

Queensland marine science

Unit 2 Marine biology

Study guide

Bob Moffatt

Wet Paper

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Marine Biology Power Points

Unit 2: Marine biology

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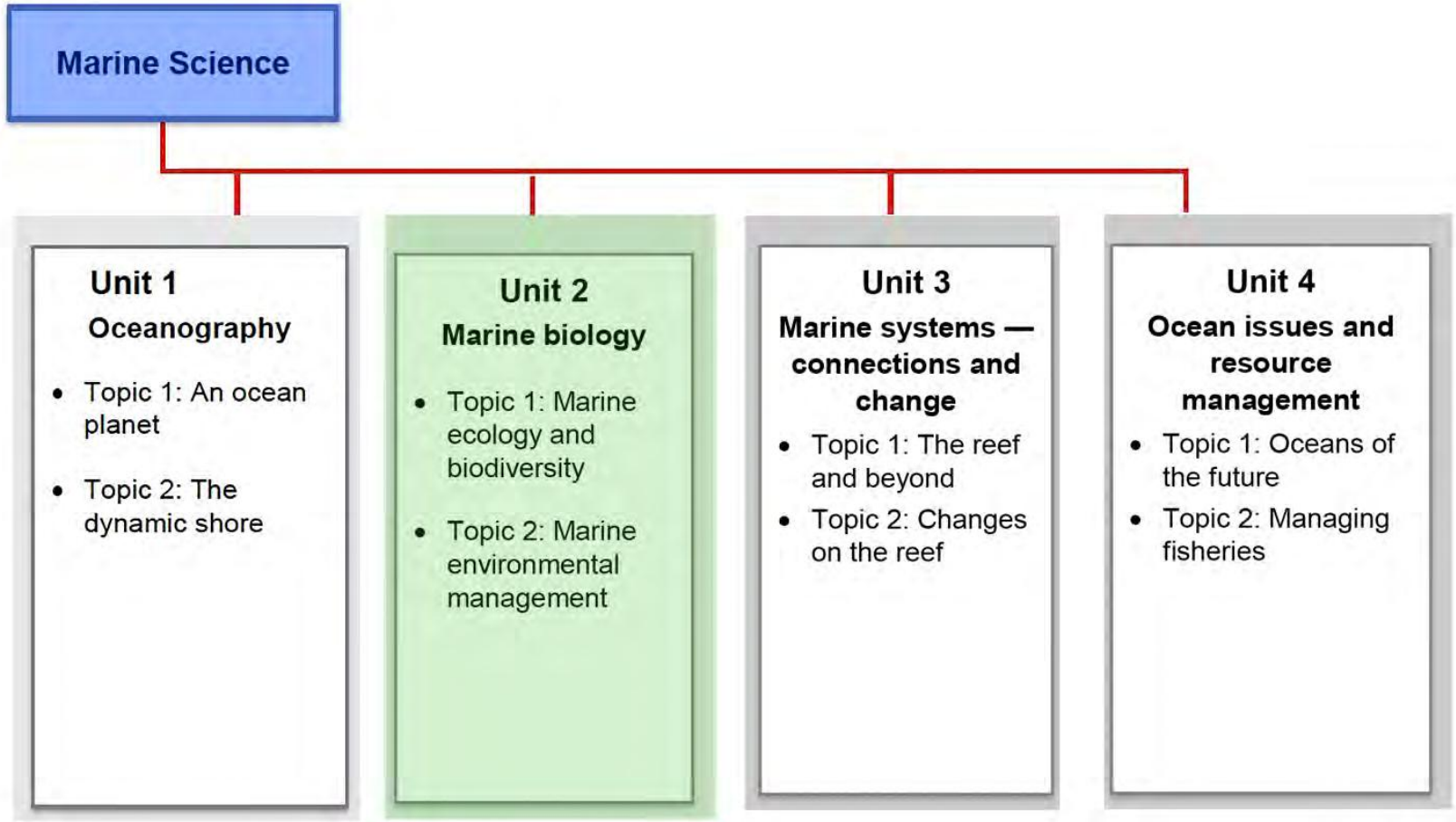
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Syllabus reference



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Classification of verbs – degree of difficulty.

★	★★	★★★
calculate (e.g. numerical answer; mathematical processes)	analyse	appraise
clarify	apply	appreciate
comprehend (meaning)	categorise	argue
construct (e.g. a diagram)	classify	assess
define	compare	comment (make a judgment)
demonstrate	consider	conduct (e.g. investigations)
describe	contrast	construct (e.g. an argument)
document	critique	create (e.g. a unique product/ artefact; language texts; meaning)
execute	deduce	decide/determine
explain	derive	discuss/explore
identify	determine	evaluate
implement (e.g. a plan, proposal)	discriminate	experiment/test (e.g. ideas, methods)
recall	distinguish	generate/test (e.g. hypotheses)
recognise (e.g. features)	identify	investigate/examine
select	infer/extrapolate	justify/prove (e.g. an argument, statement or conclusion)
understand	interpret (e.g. meaning)	modify
use		predict (e.g. a result)

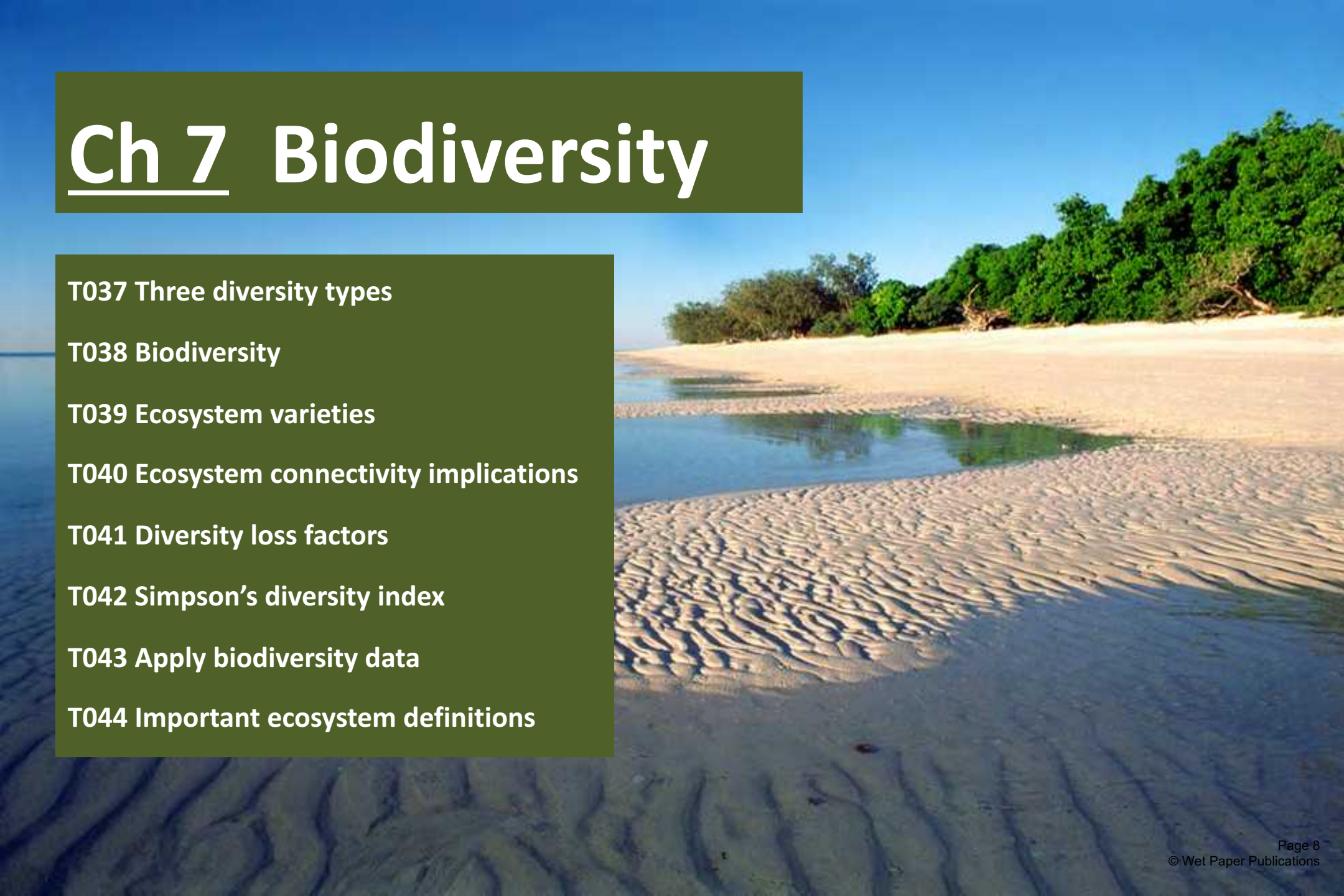
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Equipment list

Abiotic data probes	T050	Assess population data
Anemometer	T056	Population dynamic investigation
Animal plant specimens	T057	Categorise animal groups
Animal specimens	T058	Types of adaptations
Animal specimens	T059	Adaptations and survival
Artemia hatchery	T054	Assess tolerance limit data and exper
Camera	T050	Assess population data
Certificate	T051	Air and water comparisons
Certificate	T053	Limiting factors and tolerance limits
colours	T047	Trophic level classifications
Counting slide and grid	T054	Assess tolerance limit data and exper
Digital camera	T056	Population dynamic investigation
Ecosystem model	T039	Australian marine ecosystems
Ecosystem model	T040	Connectivity in marine ecosystems
Excel	T042	Simpson's diversity index
Excel	T043	Apply biodiversity data
Excel	T044	Important ecosystem definitions
Graph paper	T049	Population terms
Mangrove key	T050	Assess population data
Microscope	T054	Assess tolerance limit data and experiment
Nitrate/phosphate probes	T056	Population dynamic investigation
Oxygen probe	T056	Population dynamic investigation
pH probe	T056	Population dynamic investigation
Photos	T052	Abiotic factors of marine ecosystems
Profile stick	T050	Assess population data
Profile stick	T056	Population dynamic investigation
Quadrat square	T045	Biotic components of ecosystems
Quadrat square	T050	Assess population data
Salinity probe	T056	Population dynamic investigation
Survey sheets	T041	Diversity loss factors
Survey sheets	T061	Marine ecosystem values
Survey sheets	T062	Stakeholder roles
Survey sheets	T063	Stakeholder value systems
Temperature probe	T056	Population dynamic investigation
Test chemicals	T054	Assess tolerance limit data and experiment
Transect quadrat	T056	Population dynamic investigation
Water test equipment	T050	Assess population data
Wind data logger	T050	Assess population data

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Ch 7 Biodiversity



T037 Three diversity types

T038 Biodiversity

T039 Ecosystem varieties

T040 Ecosystem connectivity implications

T041 Diversity loss factors

T042 Simpson's diversity index

T043 Apply biodiversity data

T044 Important ecosystem definitions

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T037 Three diversity types



Bob Moffatt

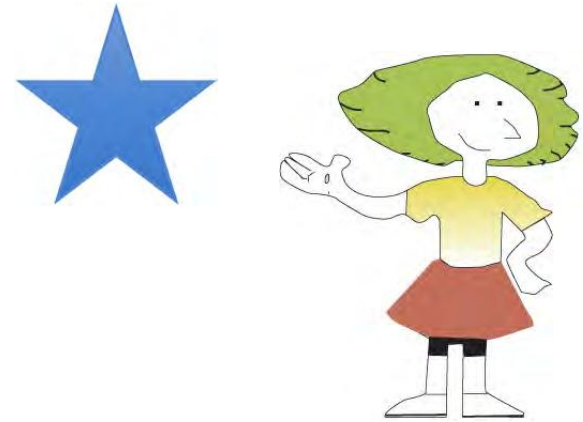
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Syllabus statement

At the end of this topic you should be able to ...

Define

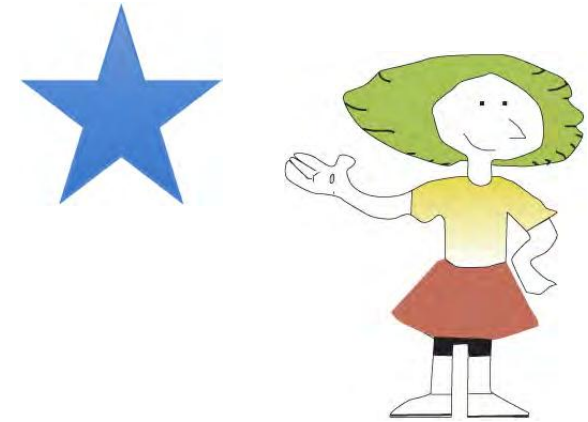
the three main types of diversity (i.e. genetic, species, and ecosystem)



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Define

give the meaning of a word, phrase, concept or physical quantity; state meaning and identify or describe qualities



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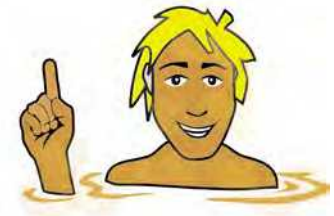
Definitions (Syllabus)

Genetic diversity:
the variety of genetic material present in a gene pool or population of a species

Species diversity:
the variety of species per unit area (e.g. habitat or a region) that includes both the number of species present and their relative abundance

Ecosystem diversity:
the variety per unit area of ecosystems, comprising the variety of habitats, number of ecological niches, trophic levels, ecological processes and the associated communities (per unit area); the largest scale of biodiversity

https://en.wikipedia.org/wiki/Species_diversity
https://en.wikipedia.org/wiki/Genetic_diversity
https://en.wikipedia.org/wiki/Ecosystem_diversity



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Objective

Define three types of diversity, give an example and state the significance of each.



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Genetic diversity

Definition - the variety of genetic material present in a gene pool or population of a species



Adult penguins with chicks

By Image ID: corp2417, NOAA Corps CollectionPhotographer: Giuseppe Zibordi
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Example

In some oceanic plankton, viruses aid in the genetic makeup of the individual. These viruses, which infect the plankton, carry genes of other organisms in addition to their own.

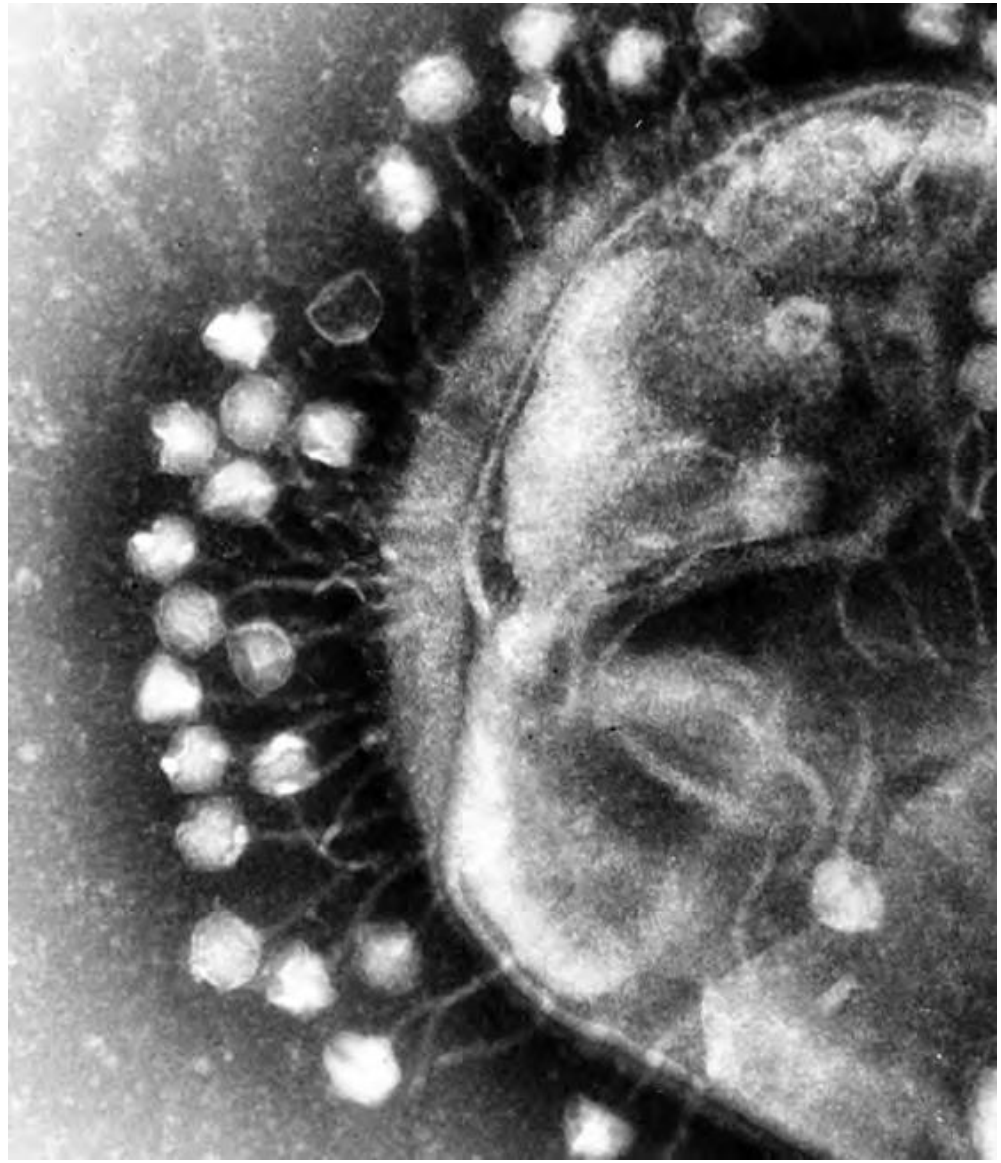


Photomontage of plankton

By Kils, CC BY-SA 3.0, https://commons.wikimedia.org/w/index.php?curid=4852729

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When a virus containing the genes of one cell infects another, the genetic makeup of the latter changes.



Bacteriophage and cell

Transmission electron micrograph of multiple bacteriophages attached to a bacterial cell wall By Dr Graham Beards - en:Image:Phage.jpg, CC BY-SA 3.0, https://commons.wikimedia.org/w/index.php?curid=5035798

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Significance

a. Genetic diversity serves as a way for populations to adapt to changing environments.

b. With more variation, it is more likely that some individuals in a population will possess variations of characteristics that are suited for the environment.

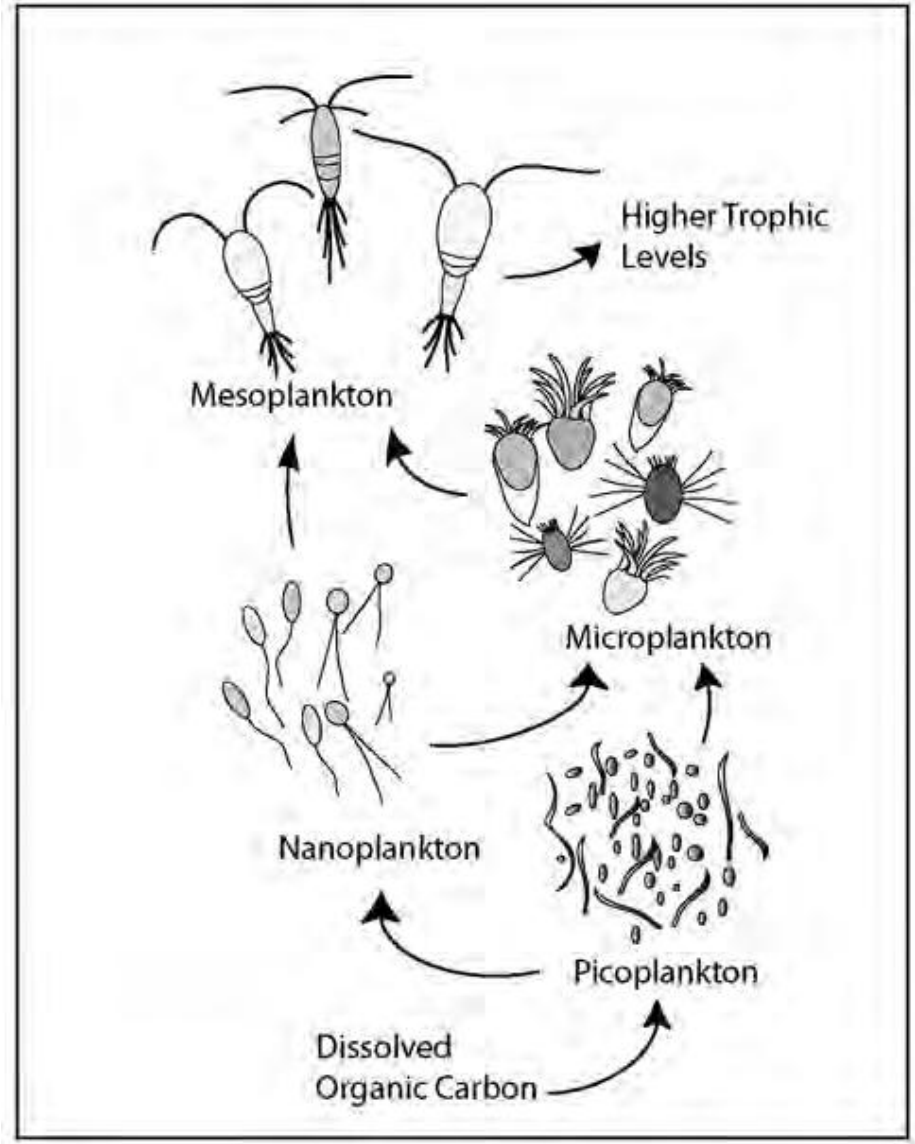
c. Those individuals are more likely to survive to produce offspring bearing that characteristic.

d. The population will continue for more generations because of the success of these individuals.



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This constant shift of genetic makeup helps to maintain a healthy population of plankton despite complex and unpredictable environmental changes.



Microbial loop

Microbial loop By Umarina at English Wikipedia - Transferred from en.wikipedia to Commons by Syp using CommonsHelper., Public Domain, https://commons.wikimedia.org/w/index.php?curid=11267447

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Species diversity

Definition

the variety of species per unit area (e.g. habitat or a region) that includes

both the number of species present and their relative abundance .



Diversity of corals on a reef

By Murray Waite Viewfinder

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Example

If there is a wide variety and biomass of seagrass.

Herbivores have a greater choice of food and a better chance of survival thus increasing the diversity of species in that area.



Dugong feeding
Qld Fisheries

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Significance

Species diversity maintains efficiency and the productivity of an ecosystem. The more species, the better the chance of survival.



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Ecosystem diversity

Definition

the variety per unit area of ecosystems, comprising

- the variety of habitats,
- number of ecological niches,
- trophic levels,
- ecological processes and
- the associated communities (per unit area).

The largest scale of biodiversity.



NASA composite view of Earth ecosystems
By Reto Stöckli (land surface, shallow water, clouds)
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Ecological diversity includes the variation in both terrestrial and aquatic ecosystems.



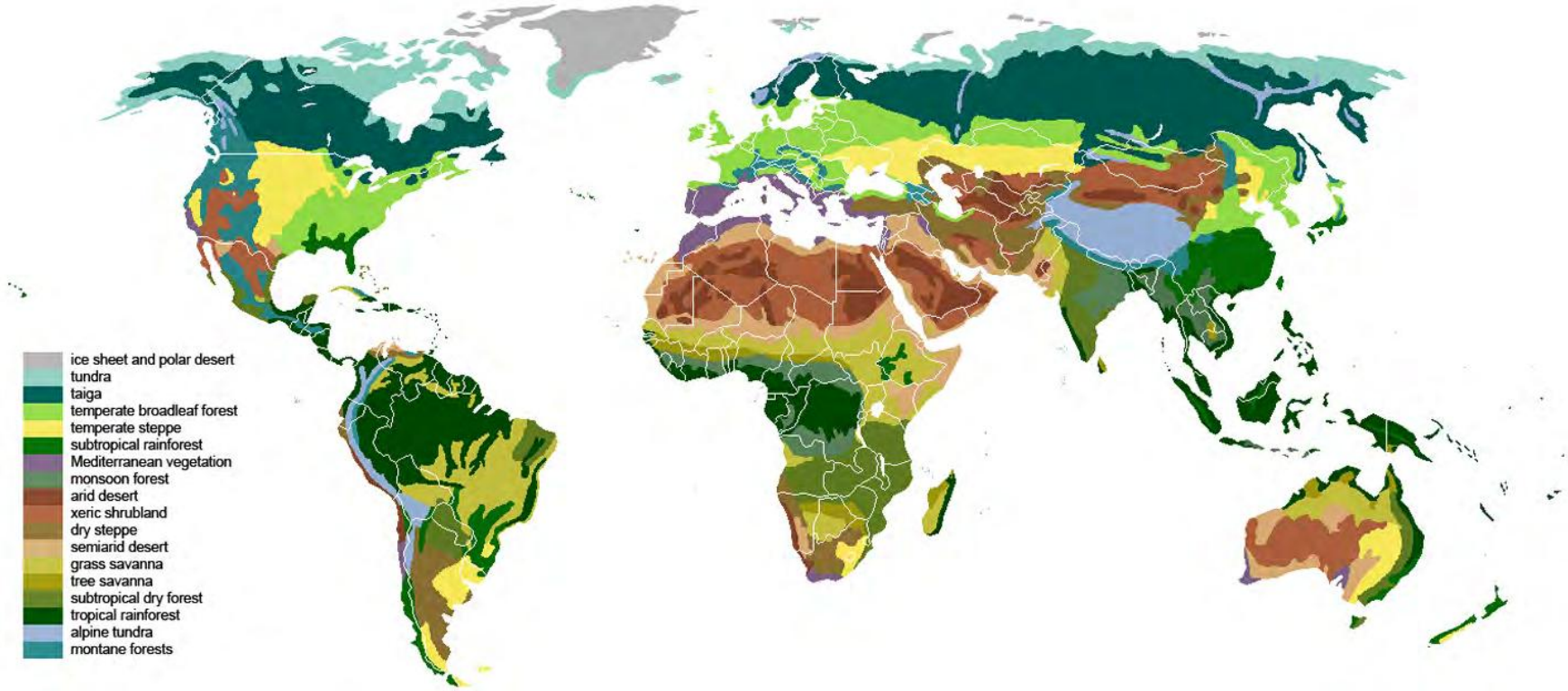
Aerial flight view land and sea

Viewfinder

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Example

An example of ecological diversity on a global scale would be the variation in ecosystems, such as deserts, forests, grasslands, wetlands and oceans.



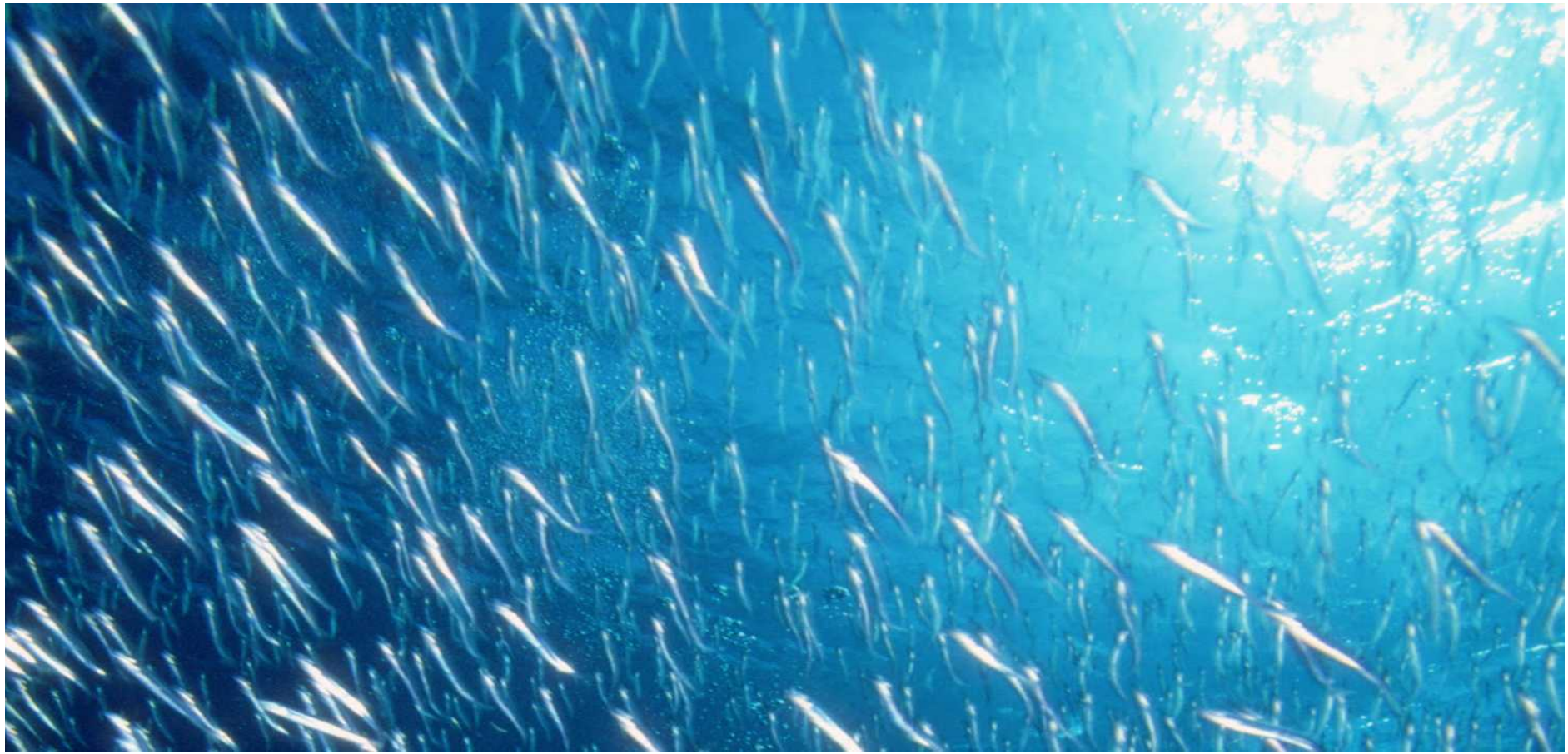
Terrestrial biomes

By Ville Koistinen (user Vzb83) - the blank world map in Commons and WSOY Iso karttakirja for the information, CC BY-SA 3.0, https://commons.wikimedia.org/w/index.php?curid=1700408

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Significance

Ecosystem diversity boosts the availability of materials in the biogeotrophic cycles, eg., oxygen.



Fish in the sunlight

Murray Waite

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Ecosystem diversity ALSO provides another way of researching by studying the variation in the complexity of a biological community, including the number of different niches, the number of trophic levels and other ecological processes.



Diver and seagrass
Qld Fisheries

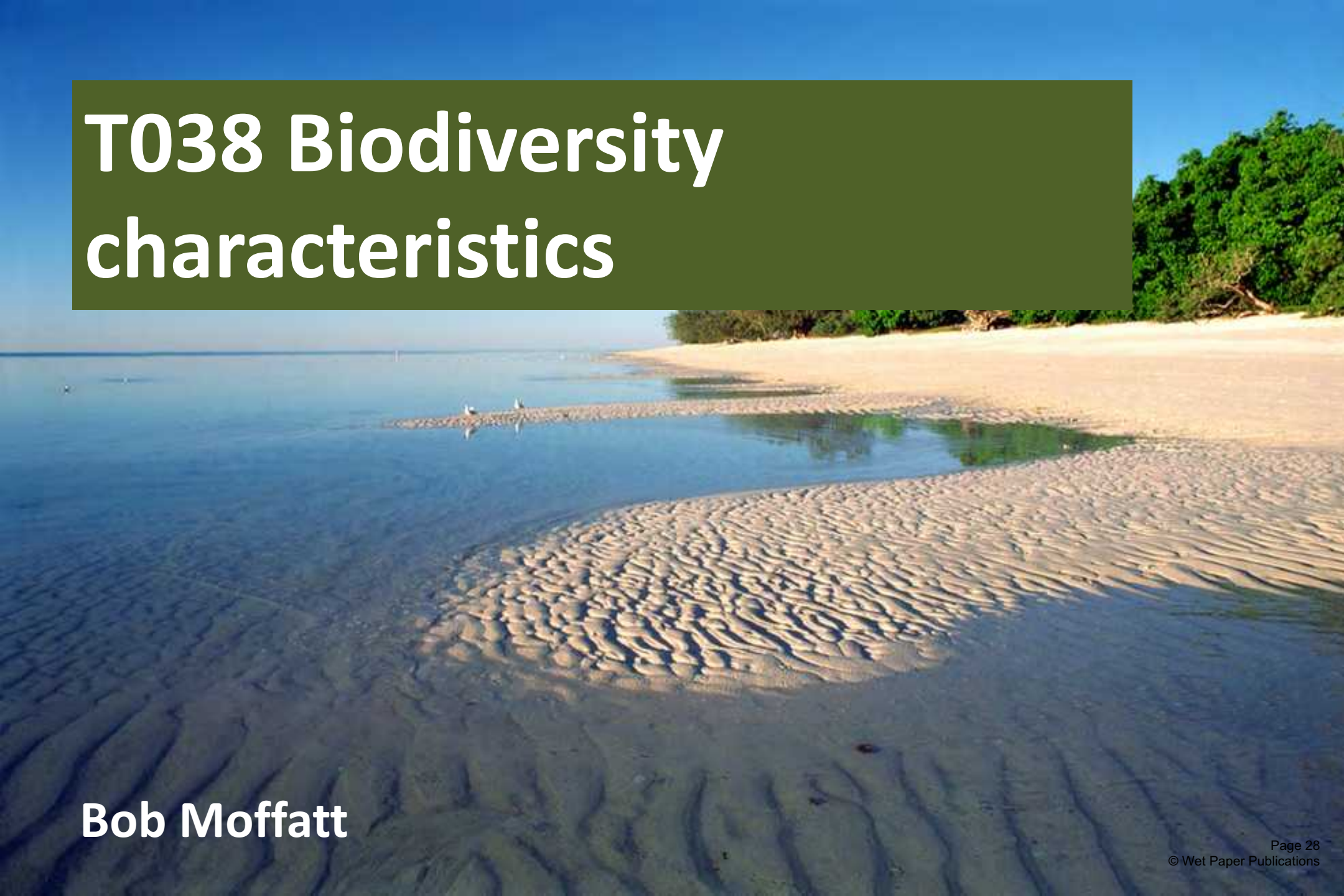
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Question

Define three types of diversity, give an example and state the significance of each.



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T038 Biodiversity characteristics

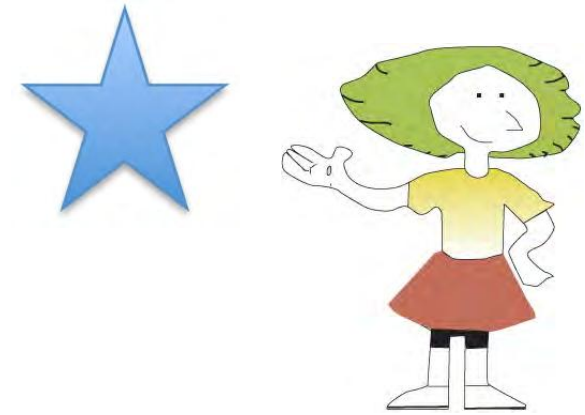
Bob Moffatt

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Syllabus statement

At the end of this topic you should be able to ...

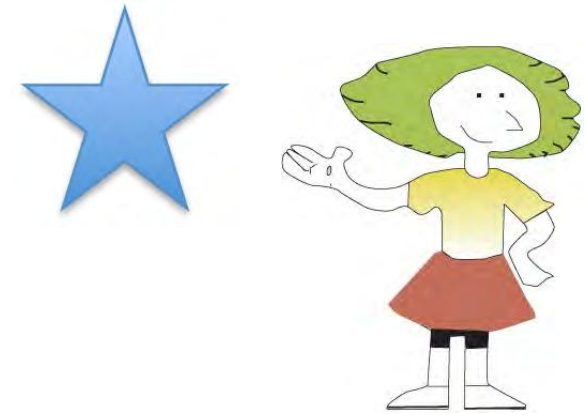
Recall three unique characteristics of marine biodiversity (i.e. wide dispersal at sea, the need for structural complexity, critical nursery habitats)



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Recall

- remember;
- present remembered ideas, facts or experiences;
- bring something back into thought, attention or into one’s mind



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Objective

State how each of the following contributes to an ecosystem's biodiversity.

A. Wide dispersal at sea

B. Structural complexity requirements

C. Critical nursery habitats



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Wide dispersal at sea

The reproductive cycle of a wide variety of marine life is dependent on the sea for dispersal, to ensure greater biodiversity in many regions, eg., across different reefs.



Open sea dispersal

Photo Bob Moffatt

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In reproductive cycles, gametes are typically small, fragile, buoyant and produced in their millions.



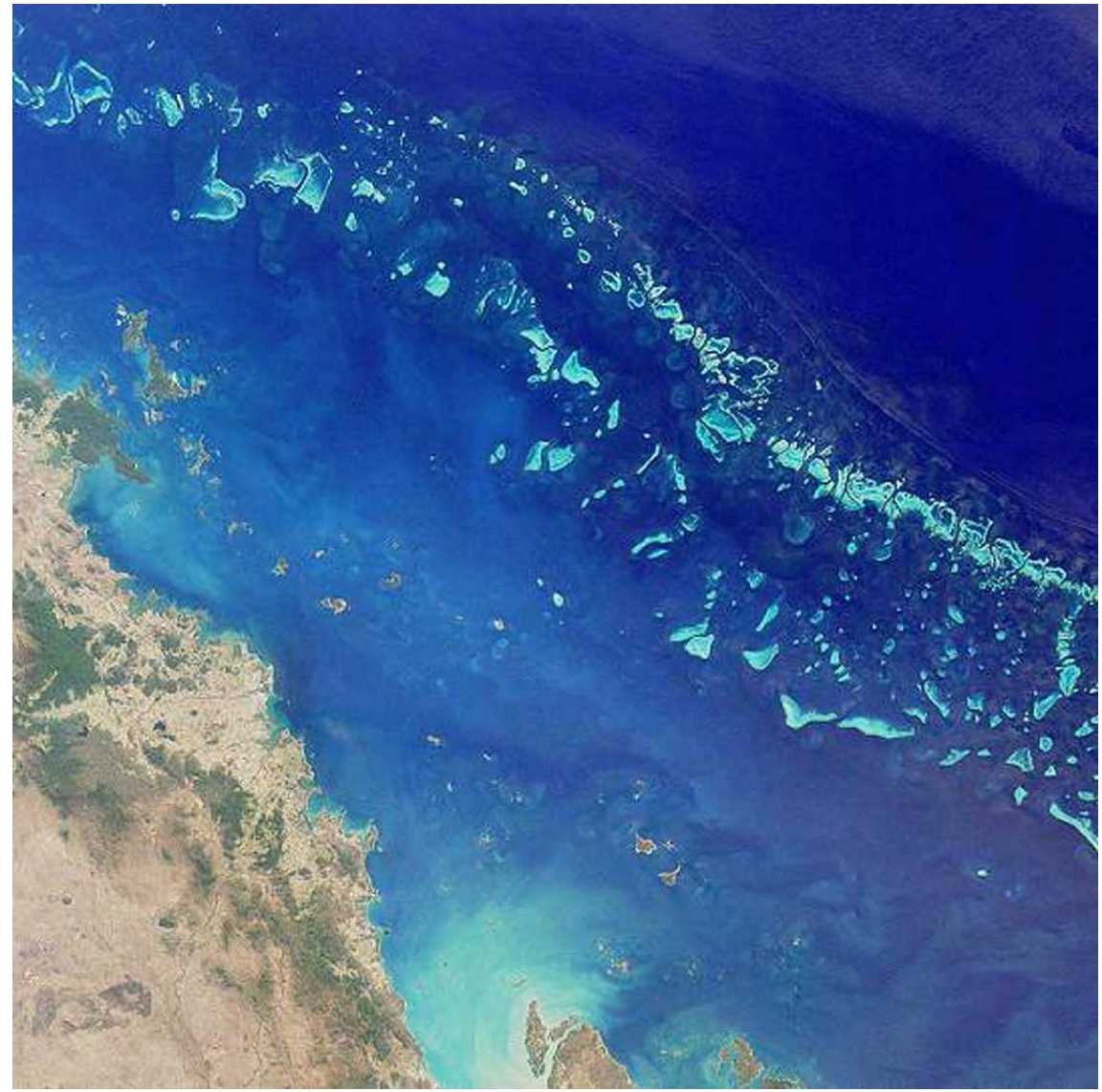


Plankton in test tube

Photo Bob Moffatt

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Currents and tides over a large area ensure that these immature stages (gametes and larvae) are dispersed over a range of habitats increasing species biodiversity by numbers across regions.

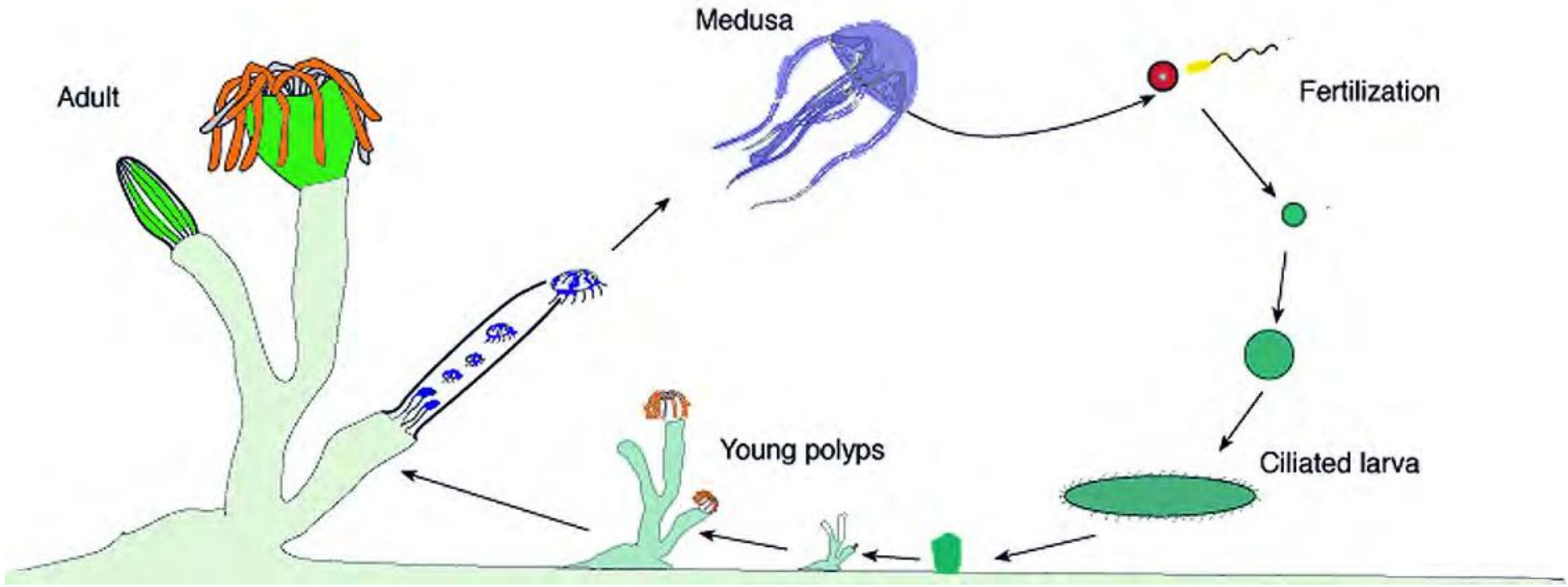


GBR Whitsunday Islands to Shoalwater Bay

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For example, sea jellies disperse planktonic larvae over large ocean areas so as to increase biodiversity with numbers.



Medusa life cycle

Illustration Bob Moffatt

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Corals disperse their young (larval polyps) in ocean currents.



Coral spawn

Photo Bob Moffatt

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Structural complexity requirements

The proper functioning of the marine environment is dependent on its ecological integrity.

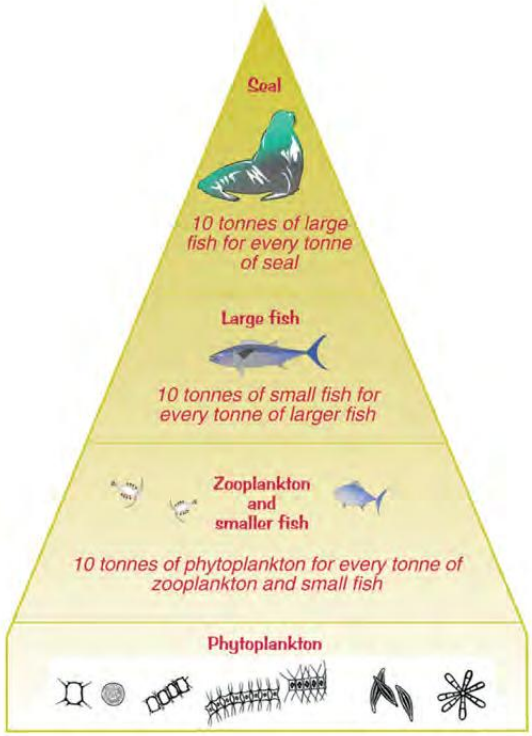


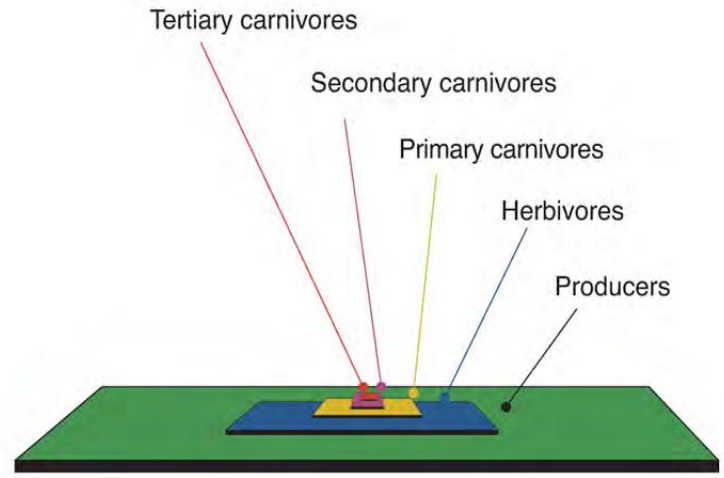
Killer whale attacks Weddell seal

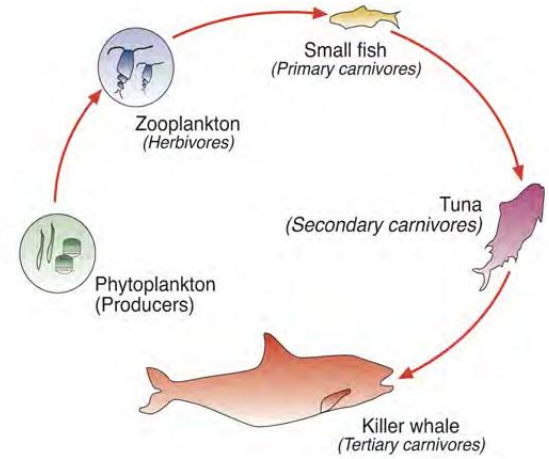
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This means that all ecosystem components are present, operational and ecologically viable, ie sufficient numbers and types to play their ecological role.





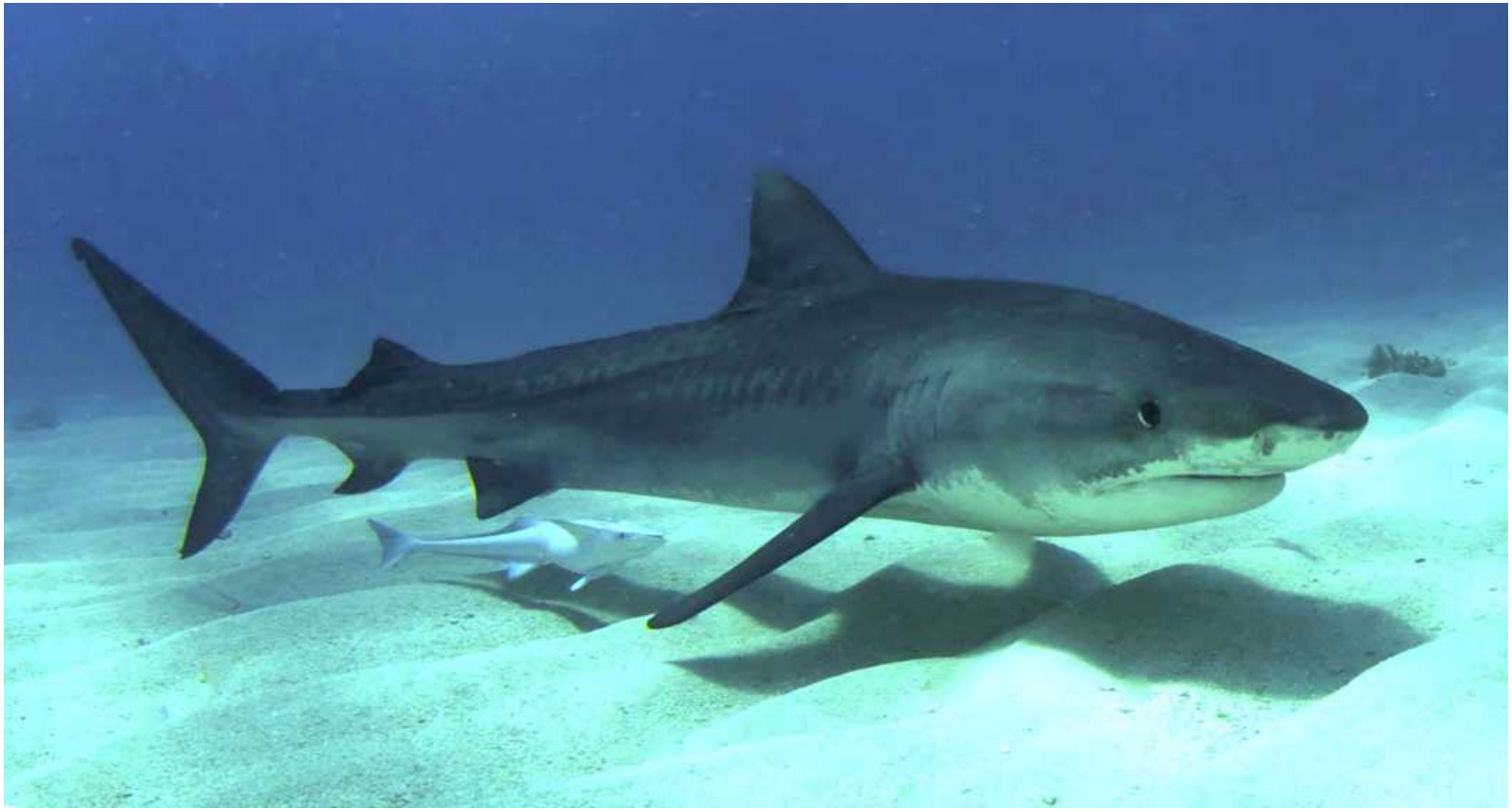


Ecosystems structures maintained

Illustration Bob Moffatt

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For example, producers and consumers must remain in place for food webs to operate effectively and higher order consumers must remain, to control lower order population sizes.



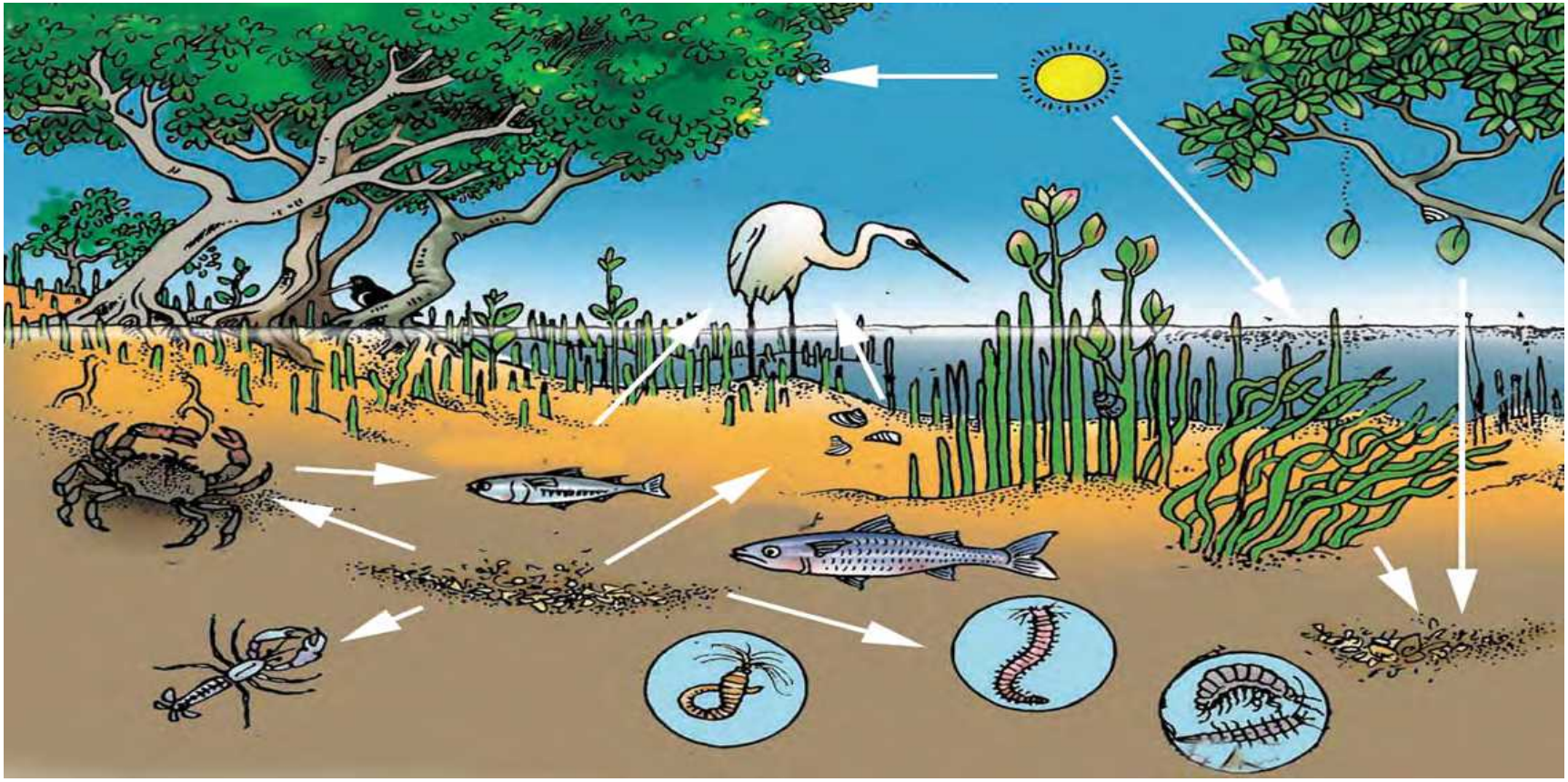
Tiger shark

By Albert kok - Own work, CC BY-SA 3.0,
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Critical nursery habitats

In marine environments, a nursery habitat is a subset of all habitats where juveniles of a species occur.



Mangrove food web structure

Illustration Sharyn Madder

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They have a greater level of productivity per unit area than other juvenile habitats.

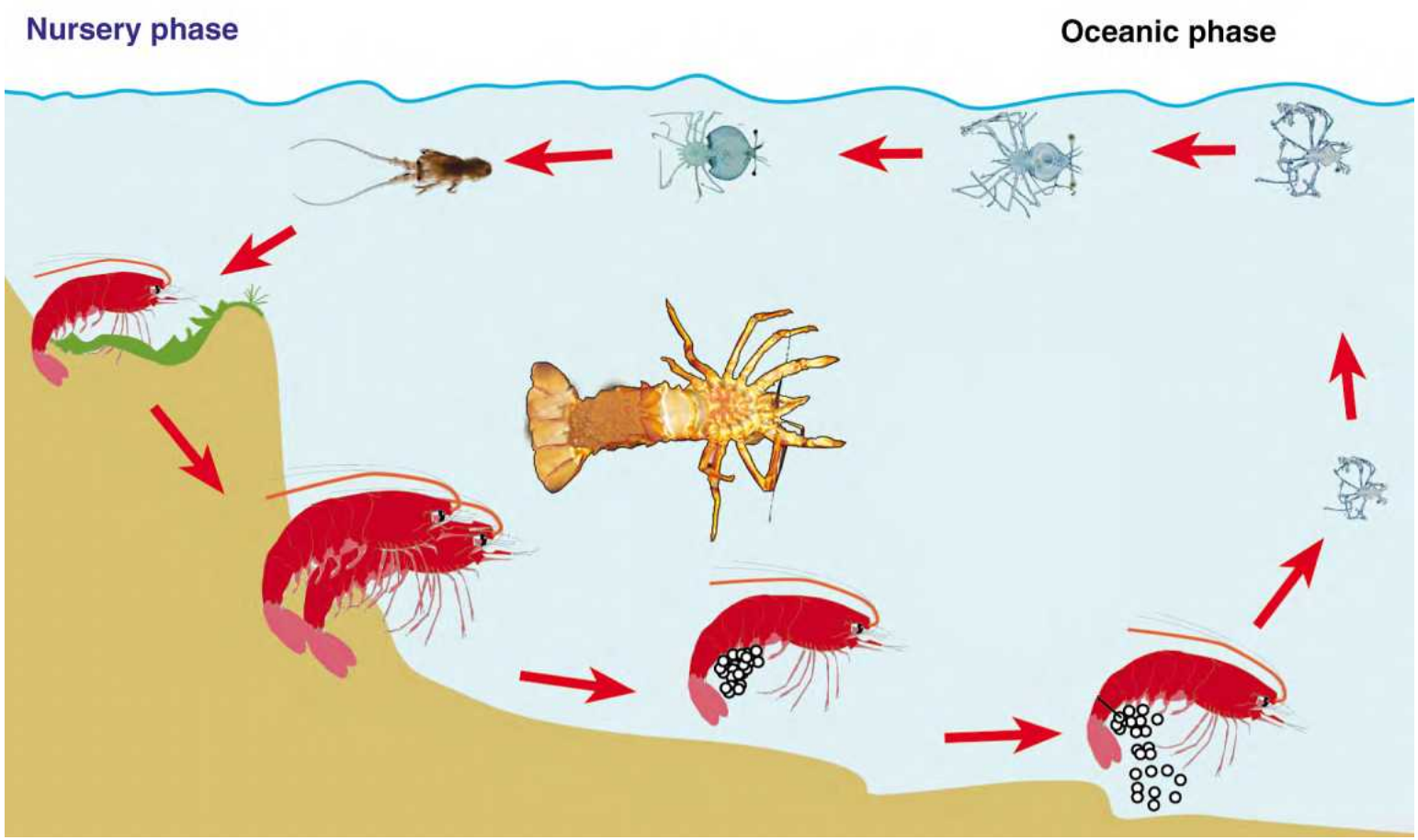


Seagrass feel

Photo Qld Fisheries

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Mangroves, salt marshes and seagrass are typical nursery habitats for a range of marine species. Seagrass is crucial to the lobster's life cycle.

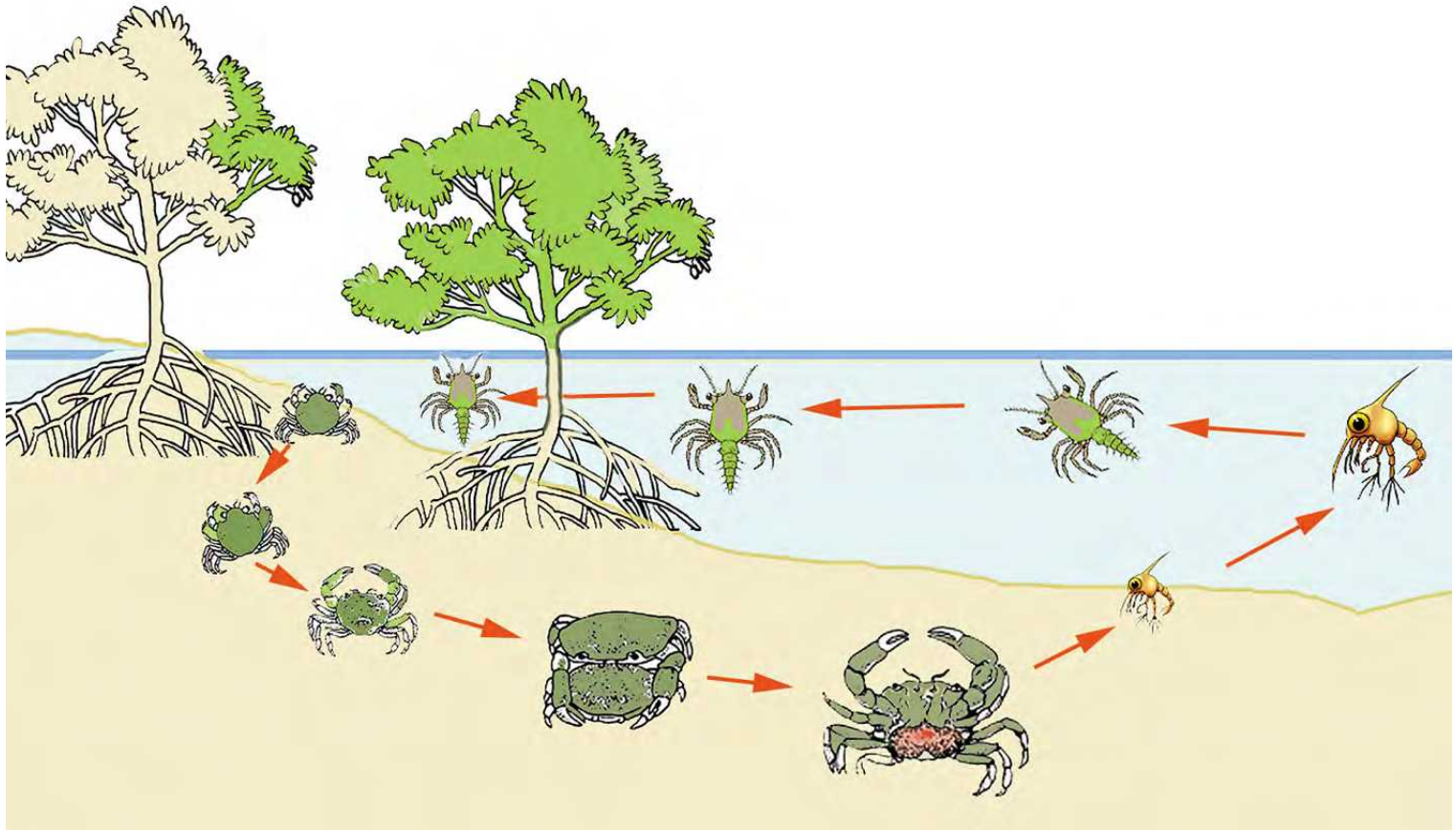


Lobster life cycle

Illustration Bob Moffatt

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If we are unable to preserve nursery habitats, recruitment of juveniles into adult populations may decline, reducing population numbers and compromising the survival of species for biodiversity and human harvesting.



Mud crab life cycle

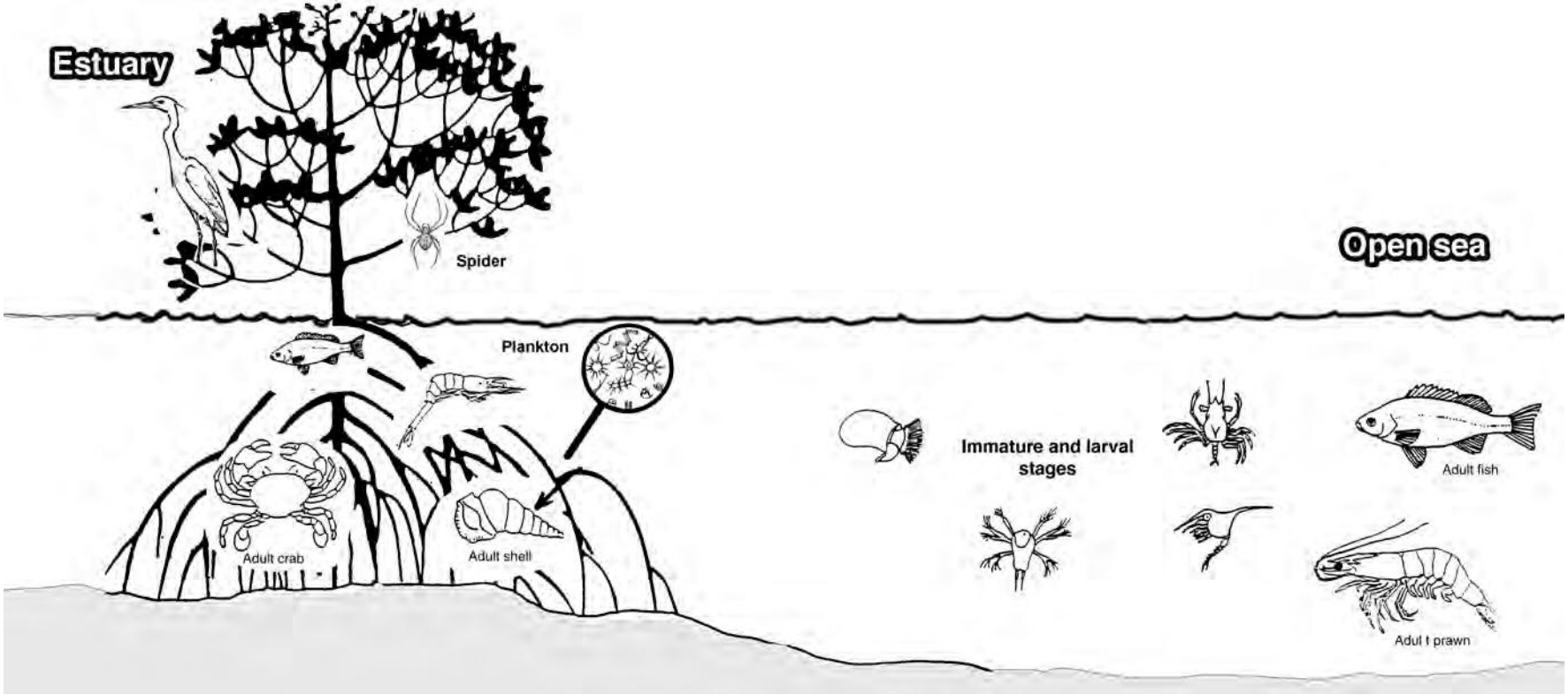
Illustration Bob Moffatt

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Question

Redraw the diagram below to show places where the following issues affect biodiversity:

- wide dispersal at sea,
- the need for structural complexity and
- critical nursery habitats.



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T039 Australian Marine Ecosystems



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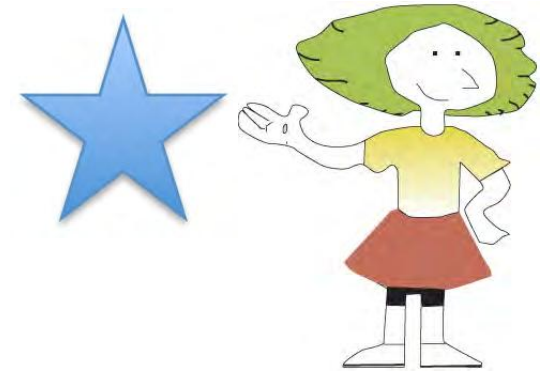
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Syllabus statement

At the end of this topic you should be able to ...

Identify

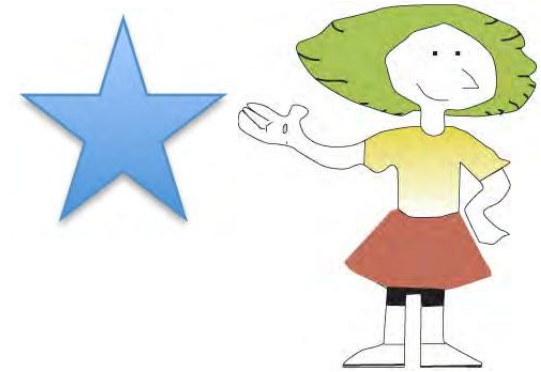
the variety of ecosystems (e.g. estuaries, coastal lakes, saltmarshes, mangroves, seagrass, rocky shores, temperate reefs, coral reefs, lagoons, shelf and deep water) that constitute Australia's marine biomes



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Identify

- locate, recognise and name;
- establish or indicate who or what someone or something is;
- provide an answer from a number of possibilities;
- recognise and state a distinguishing factor or feature.



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Definition

A biome is a community of plants and animals that have common characteristics for the environment they exist in.

Biomes are distinct biological communities that have formed in response to a shared physical climate.

"Biome" is a broader term than "habitat"; any biome can comprise a variety of habitats.

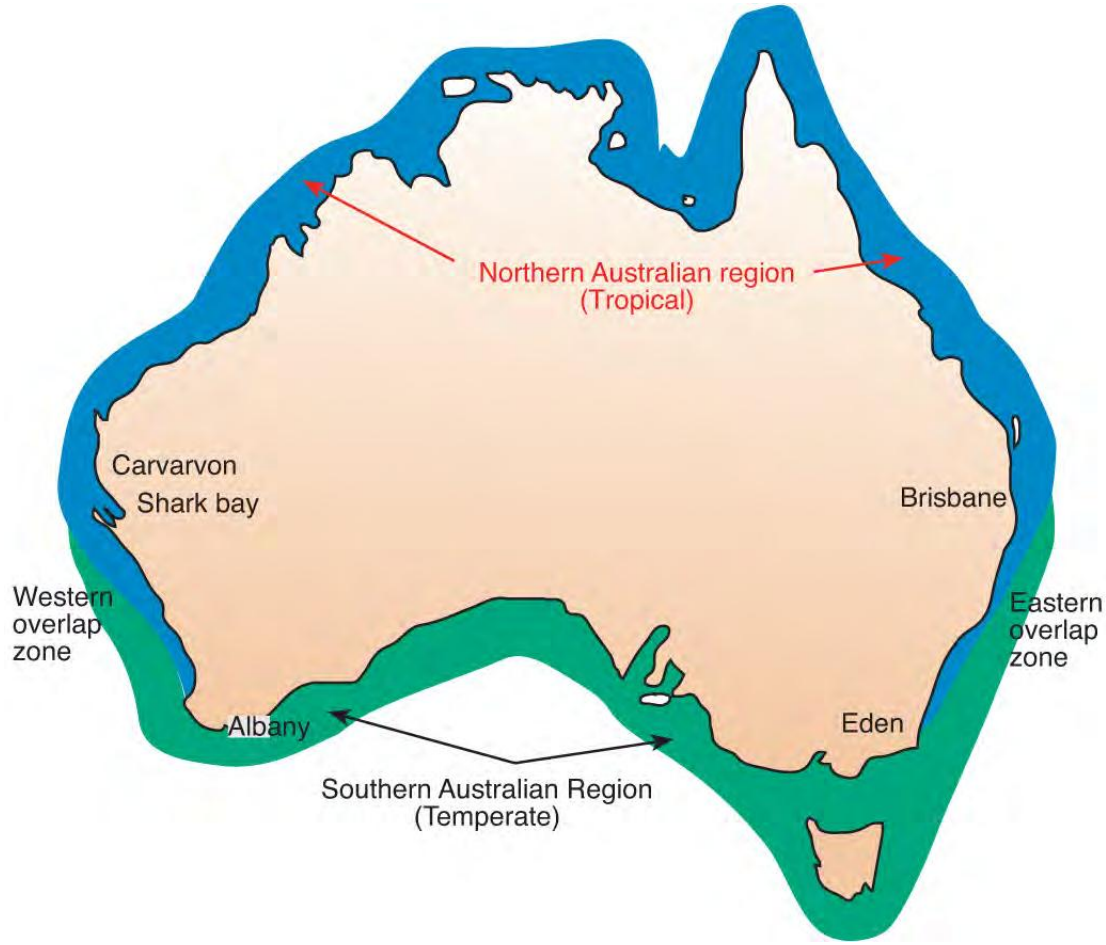


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Australian marine biomes are influenced by two climatic regions, tropical and temperate.

The transitional boundary between the tropical and warm temperate marine provinces, coincides approximately with 18-20^{o}C winter minimum surface temperature.

This is variable and dependent on the influence of the East Australian Current and the Leeuwin Current.

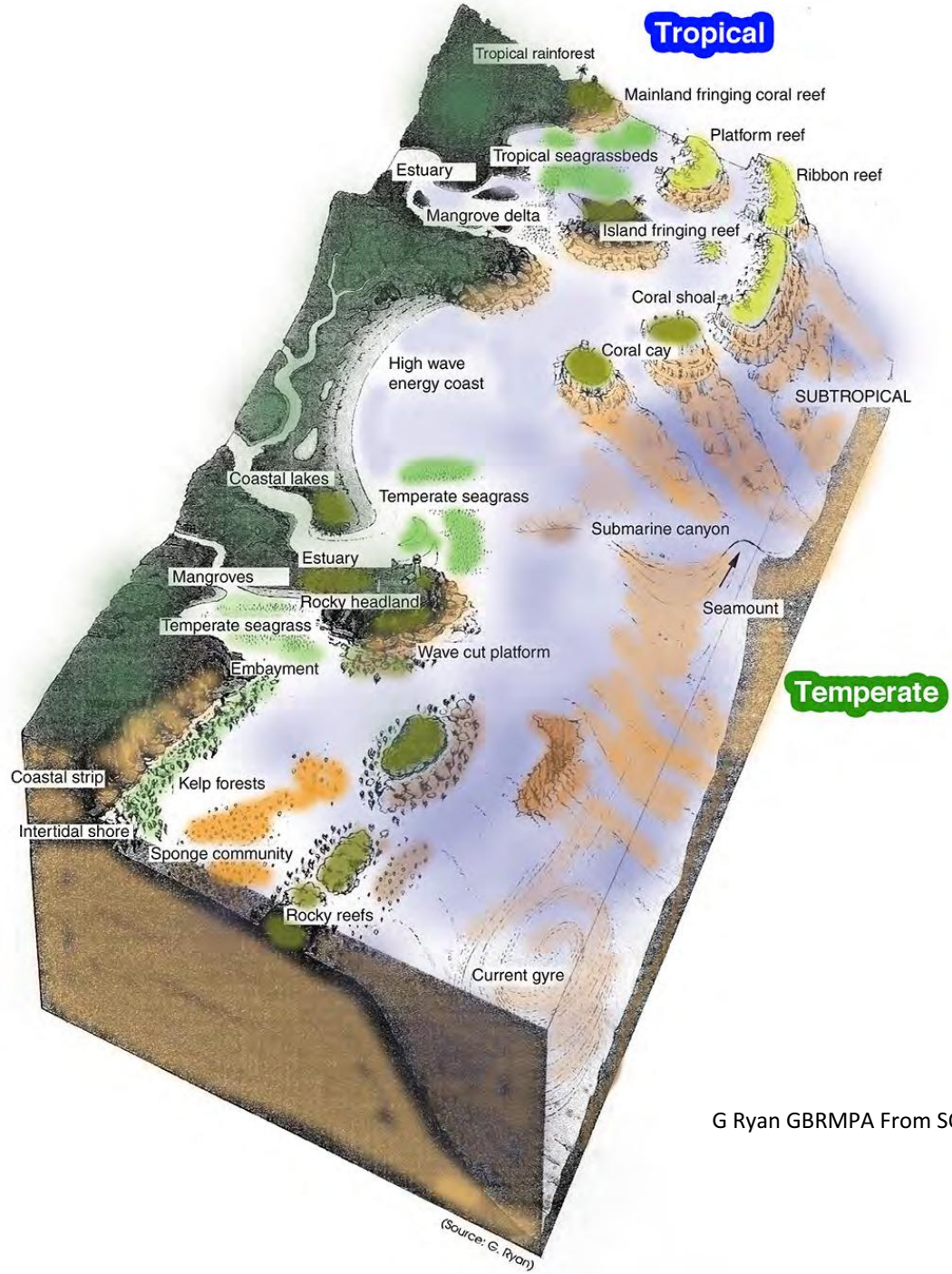


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Within these marine biomes, 26 ecosystems were identified by the State of the Marine Environment Report.

Ten are described in this illustration.



G Ryan GBRMPA From SOMER 1998

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Objective

From the list of marine ecosystems below, write a definition which includes a distinguishing feature. Then give an example from Queensland.

A. Estuaries

B. Coastal lakes

C. Saltmarshes

D. Mangroves

E. Seagrass

F. Rock pools

G. Tropical reefs

H. Coral reefs

I. Lagoons

J. Shelf



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Estuaries

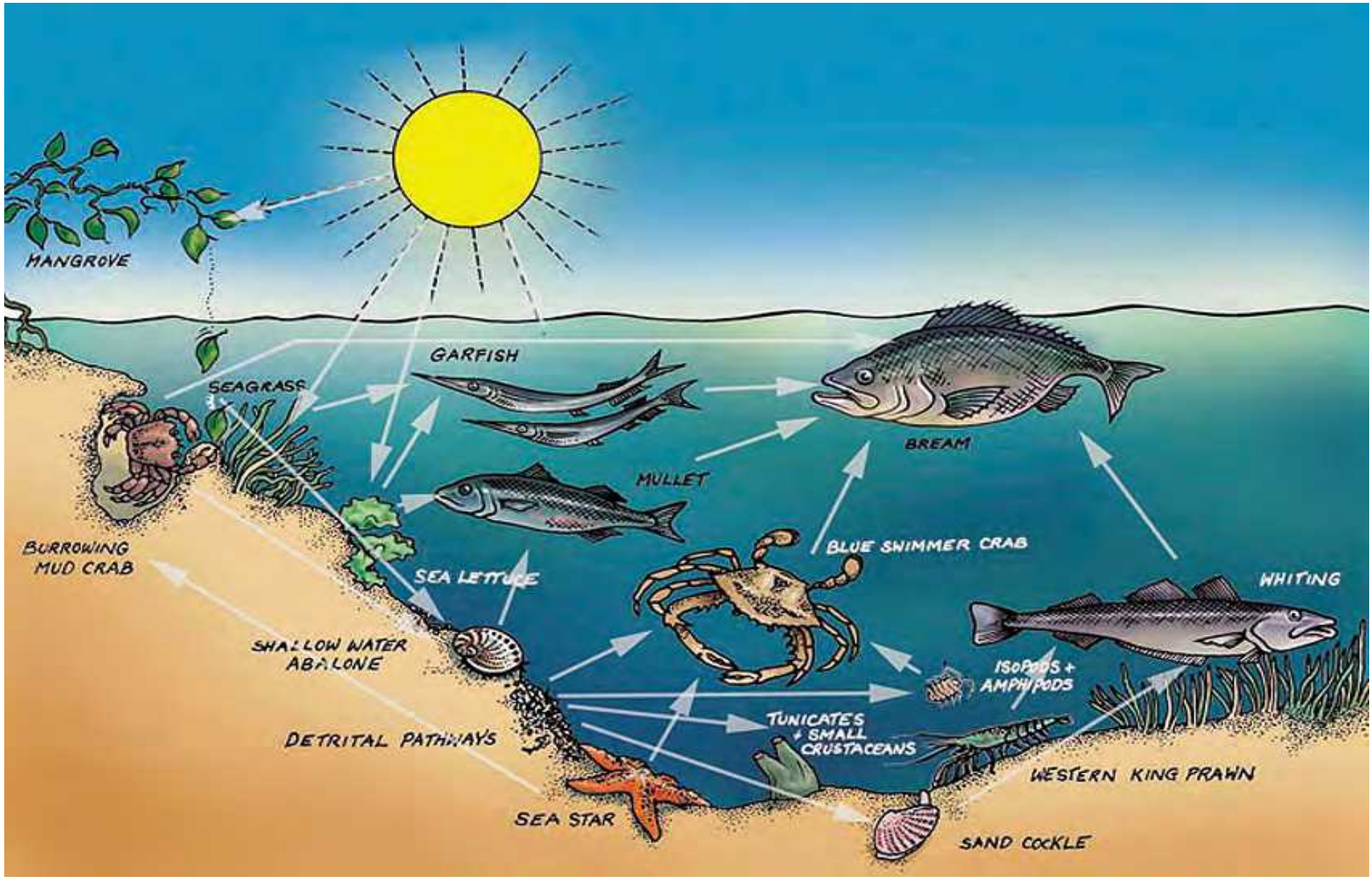
An estuary is a partially enclosed coastal body of brackish water with one or more rivers or streams flowing into it, and with a free connection to the open sea.



Example Trinity Inlet Cairns.

https://www.fishingcairns.com.au/locations/trinity-inlet-cairns-harbour-guide/

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Kerry Kitzelman

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Coastal lakes

A coastal lake is a body of coastal water with a barrier between it and the sea.
Example: Lake McKenzie, Fraser Island.



Photo Bob Moffatt

© Wet Paper Publications



Example: Lake McKenzie - Fraser Island

By Sensenmann - Own work, Public Domain, https://commons.wikimedia.org/w/index.php?curid=825954

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Saltmarshes

A saltmarsh is a body of water in the upper coastal intertidal zone between land and open saltwater or brackish water that is regularly flooded by the tides.



Example: Marine reserve Burleigh Heads

Photo Bob Moffat

© Wet Paper Publications

Saltmarsh low tide



Photo Bob Moffat

© Wet Paper Publications

Mangroves

A mangrove is a salt tolerant shrub or small tree growing often in low oxygenated mud in intertidal coastal saline or brackish water.

Example: Mangrove forest, Mackay region



Photo Qld Fisheries

© Wet Paper Publications



© Wet Paper Publications

Seagrass

Seagrasses are flowering plants which grow in marine, fully saline environments.

Example: Seagrass bed, Moreton Bay.

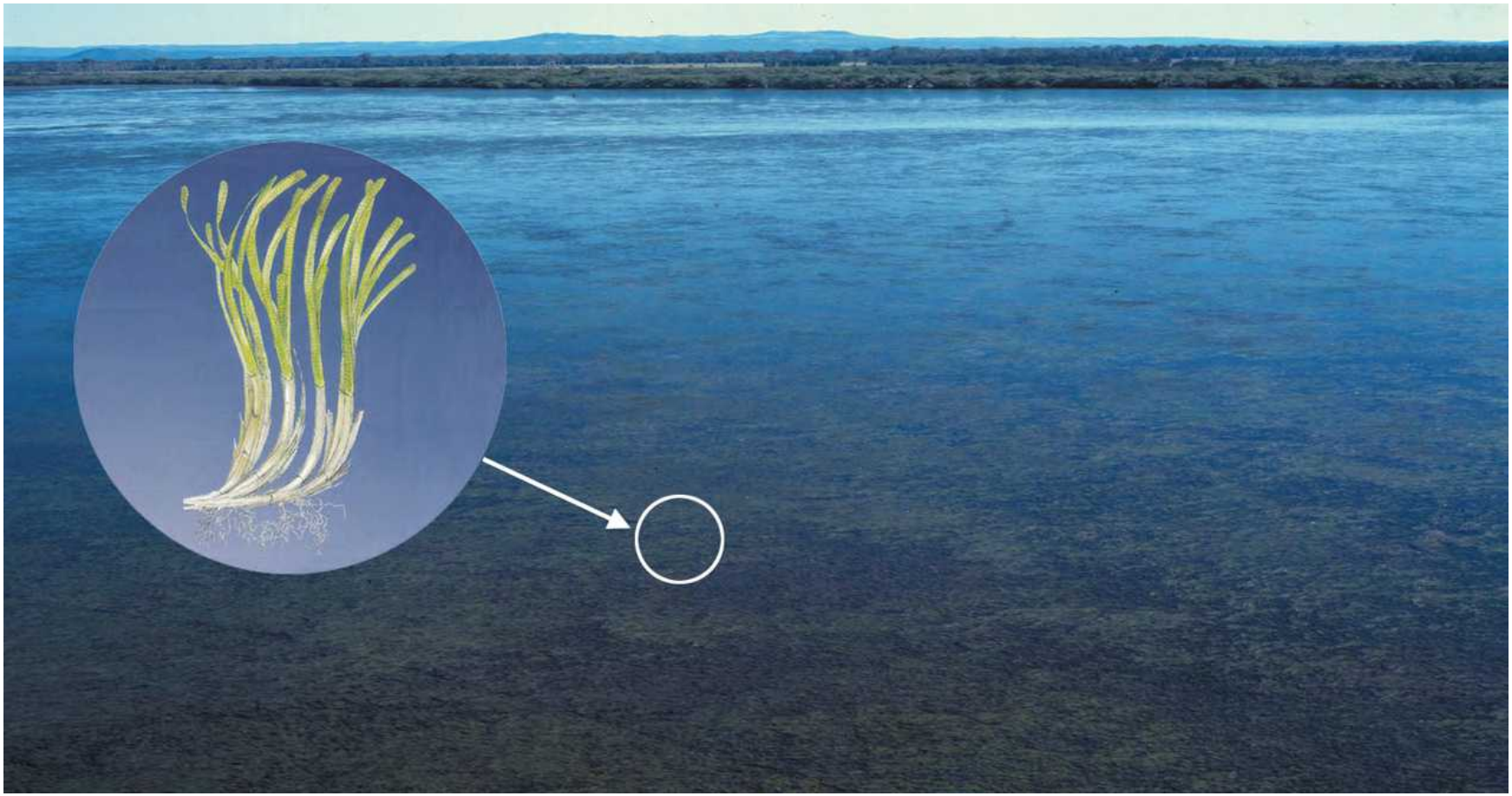
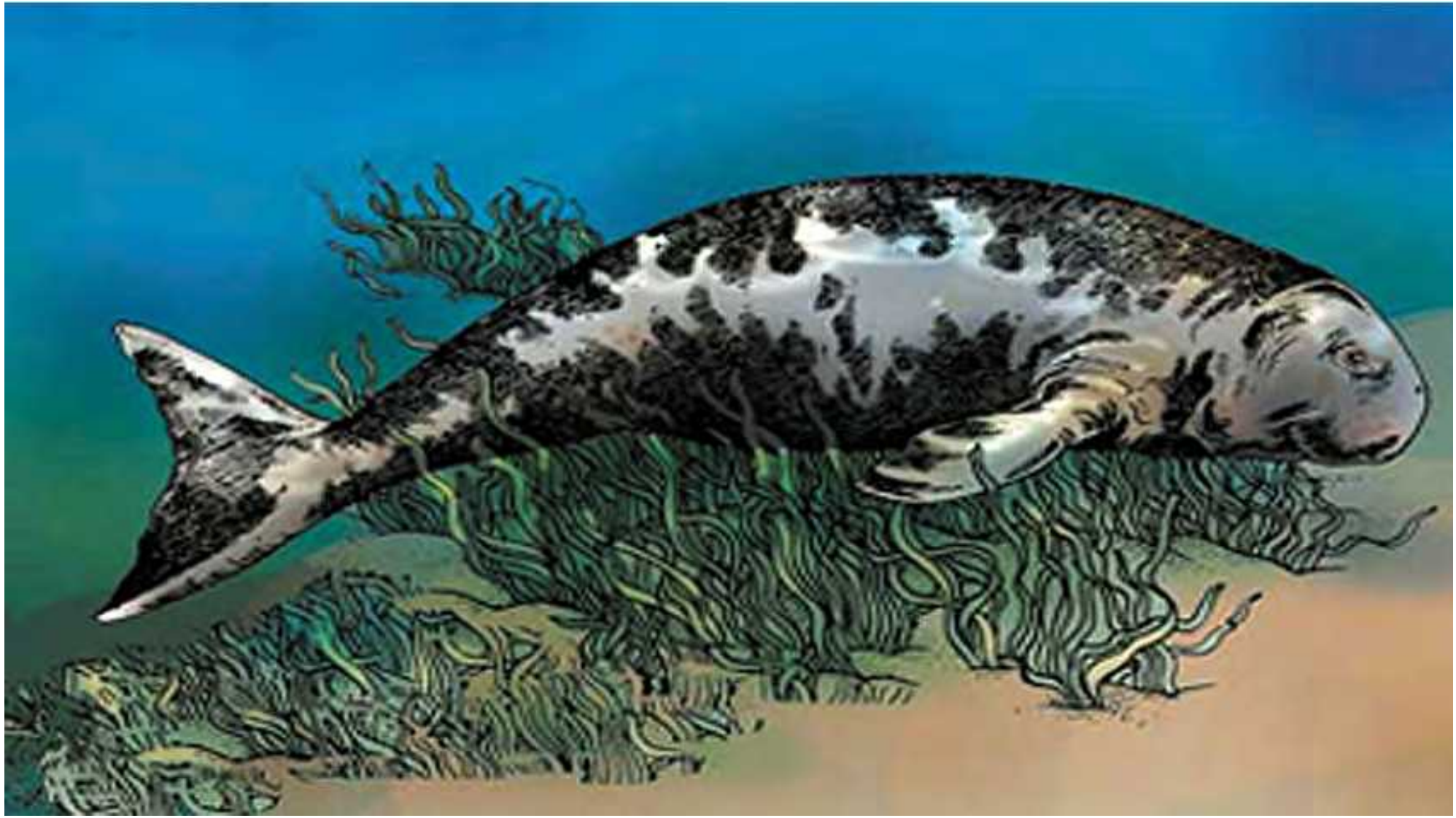


Photo Qld Fisheries

© Wet Paper Publications

They are an essential food source for dugongs.



Kerry Kitzelman

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Rock pools

Rock pools are shallow pools of seawater that form on the rocky intertidal shore. Many of these pools exist as separate bodies of water only at low tide.

Example: Rock pool Hervey Bay.



Photo Bob Moffatt

© Wet Paper Publications

Some temperate zone rock pool life.



Illustration Sharyn Madder

© Wet Paper Publications

Tropical reefs

A reef is a bar of rock, sand, coral or similar material, lying beneath the surface of water. Many reefs result from abiotic processes (i.e. deposition of sand, wave erosion planing down rocky outcrops, and other natural processes).

Example: A fringing reef made from continental rocks and attached coral outcrops.



Lizard Island

By Emily Cox [CC BY-SA 4.0 (https://creativecommons.org/licenses/by-sa/4.0)], from Wikimedia Commons
https://commons.wikimedia.org/wiki/File:Lizard_Island_Reef.jpg

© Wet Paper Publications

Some tropical zone reef life.

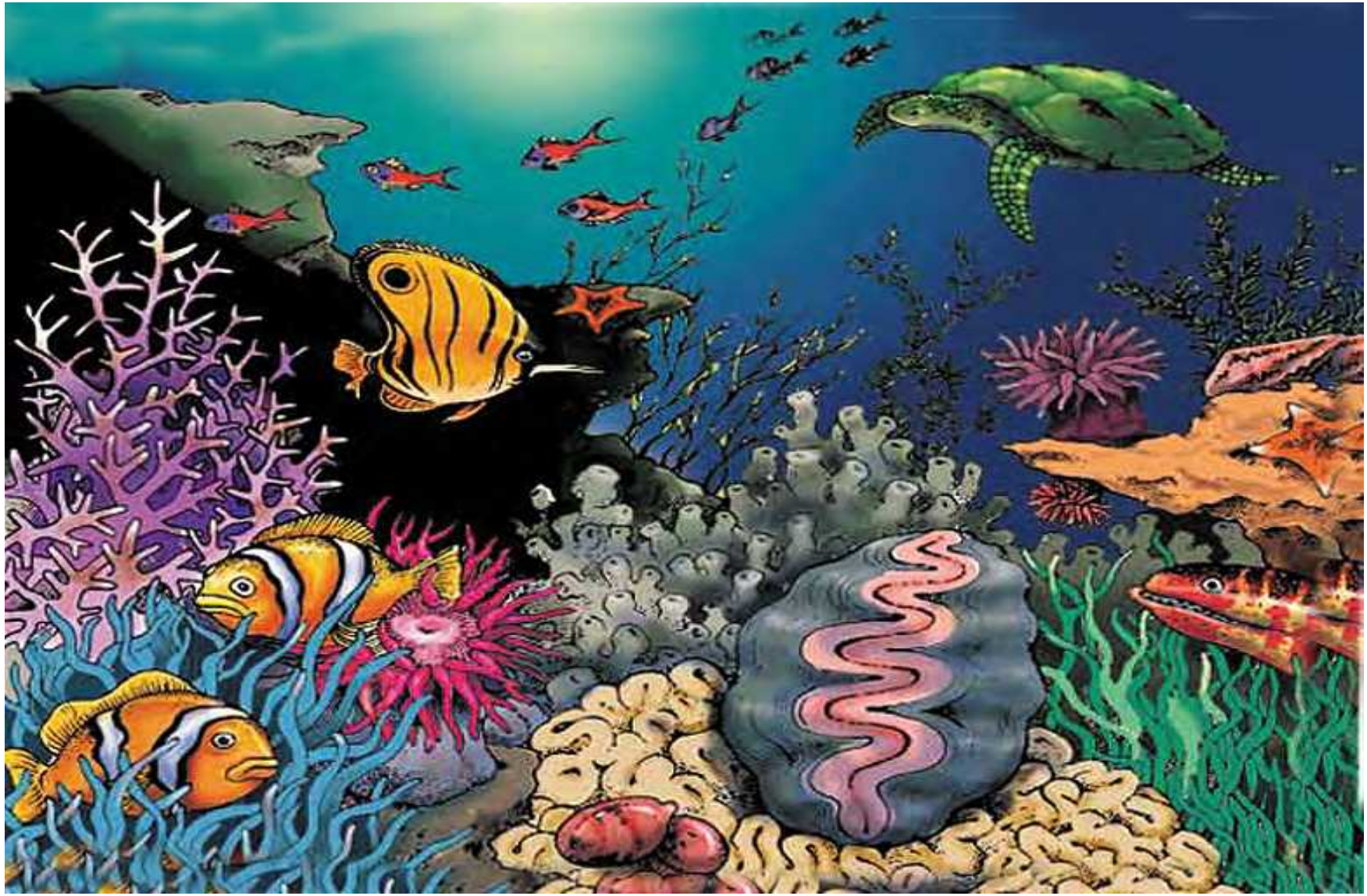


Illustration Sharyn Madder

© Wet Paper Publications

Coral reefs

Coral reefs are diverse underwater ecosystems held together by calcium carbonate structures secreted by corals.
Example: A ribbon reef would be an example of a coral reef.



Ribbon reef
Murray Waite

© Wet Paper Publications

Lagoons

A lagoon is a body of coastal water with a sand or reef barrier that can intermittently close with sand accretion, formed by longshore drift or the tide.

Example: Lagoon, North West Island.



Murray Waite

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Bob Moffatt

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Shelf

A continental shelf is a portion of a continent that is submerged under an area of relatively shallow water known as a shelf sea.

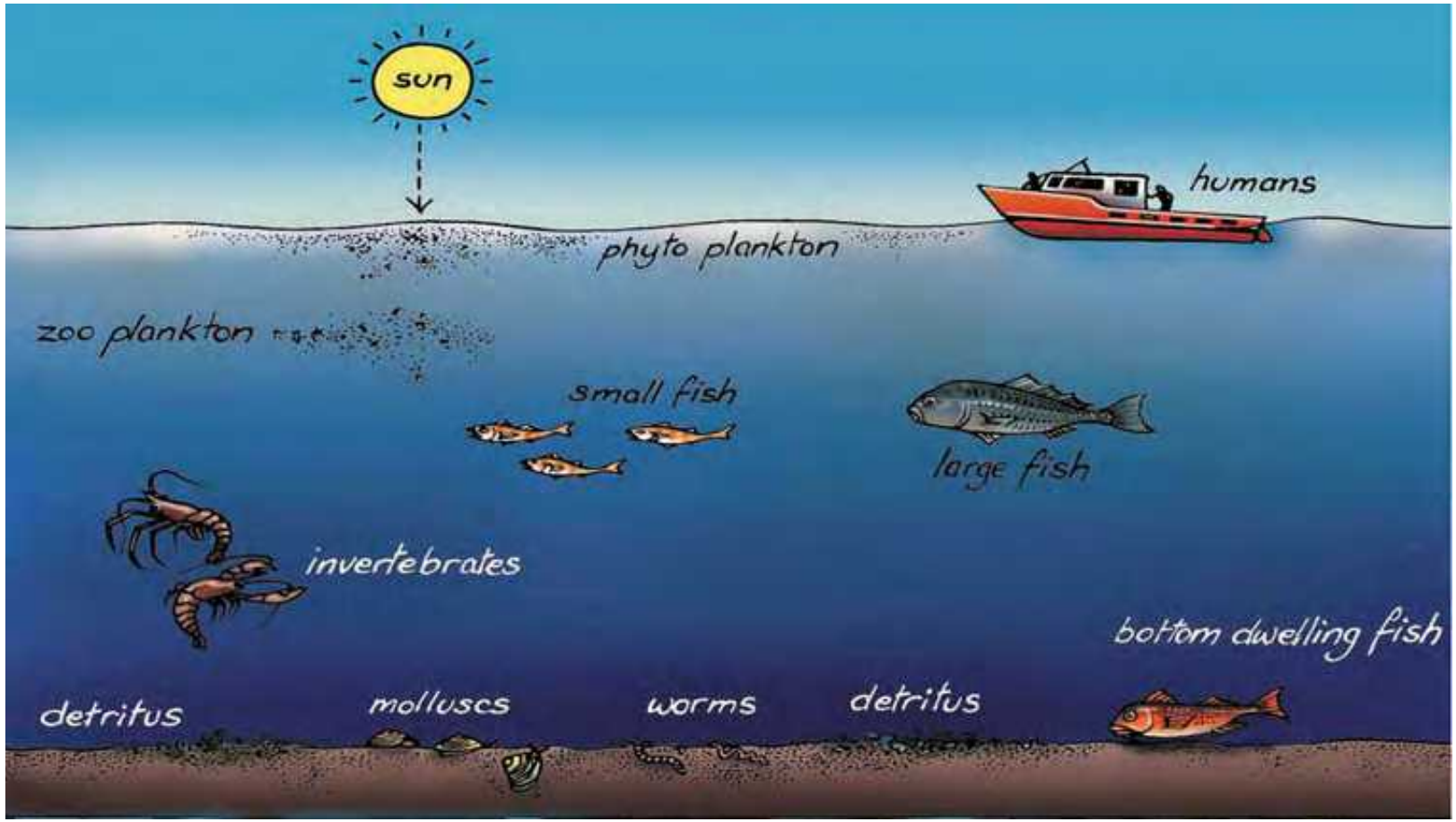


Illustration Sharyn Madder

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Question

Complete the following table to show you can identify the listed ecosystems in Queensland.

Ecosystem	Definition	Example from Queensland coastline
Estuary		
Coastal lake		
Saltmarsh		
Mangroves		
Seagrass		
Rock pools		
Tropical reefs		
Coral reefs		
Lagoons		
Shelf		

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Project work

Make a model of your coastline to include

A. Estuary

B. Coastal lake

C. Saltmarsh

D. Mangroves

E. Seagrass

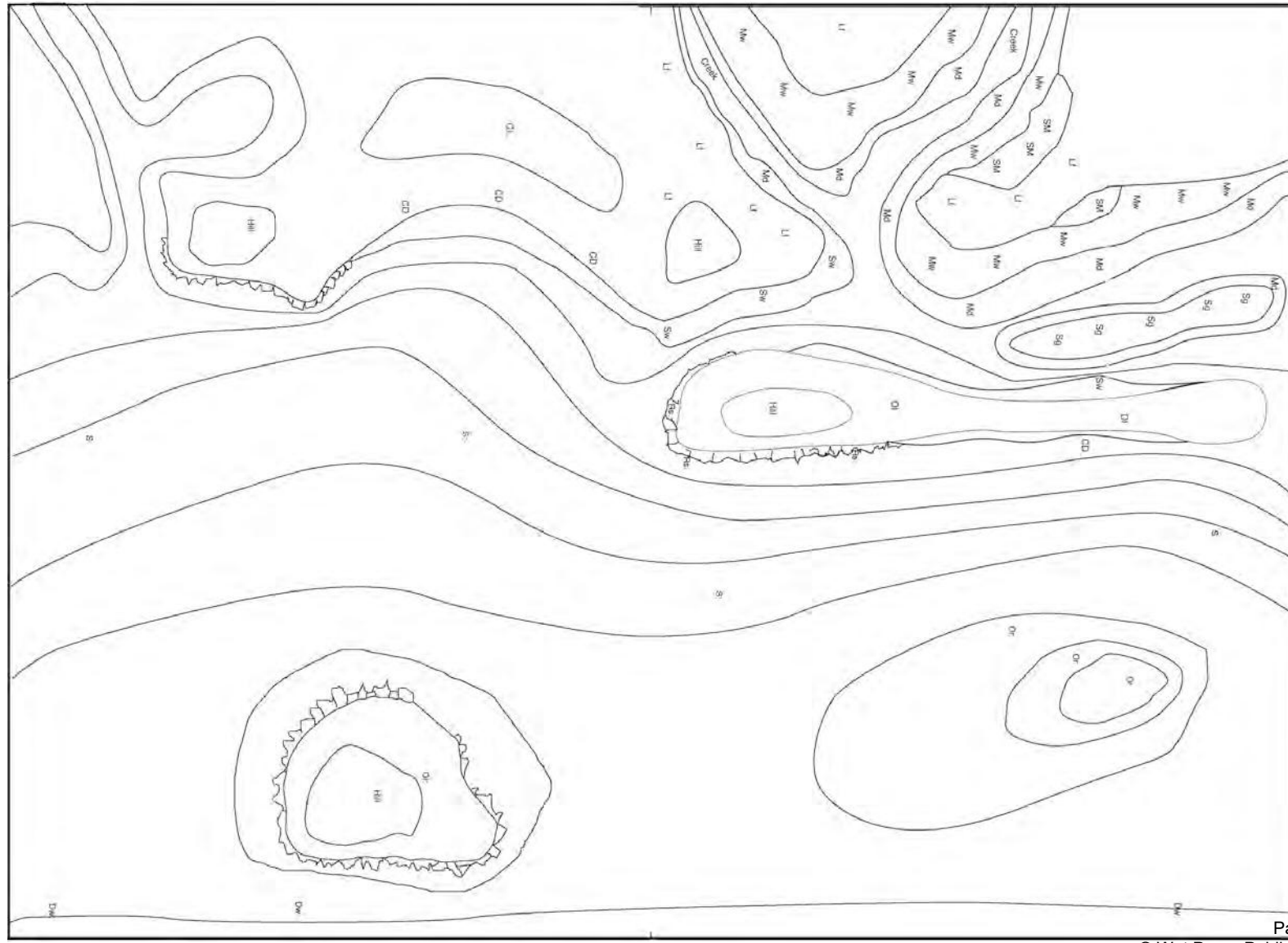
F. Rock pool

G. Offshore reef or coral reef

I. Lagoon

J. Shelf

k. Deep water



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A. Estuary

B. Coastal lake

C. Saltmarsh

D. Mangroves

E. Seagrass

F. Rock pool

G. Offshore reef or coral reef

I. Lagoon

J. Shelf

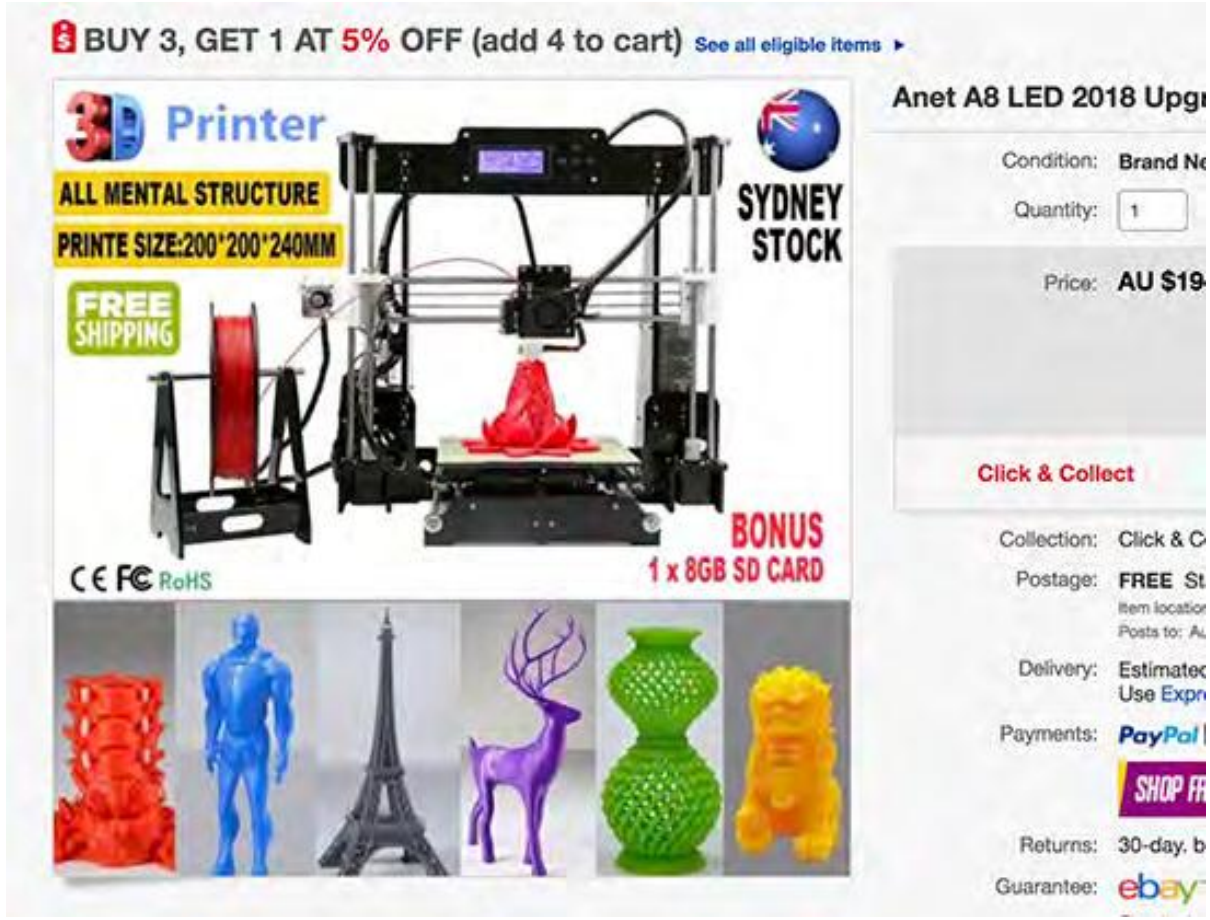
k. Deep water



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Your challenge

Using google Earth images – use a 3 d printer to make a model coastline to show the ecosystem varieties in you local area.



https://www.ebay.com.au

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T040 Connectivity in marine ecosystems



Bob Moffatt

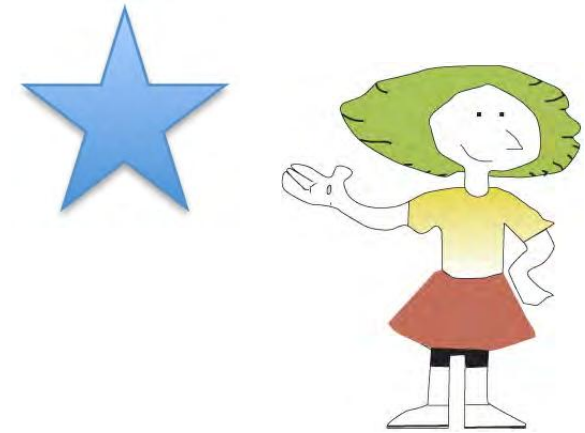
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Syllabus statement

At the end of this topic you should be able to ...

Describe

the implications of connectivity to marine ecosystems.



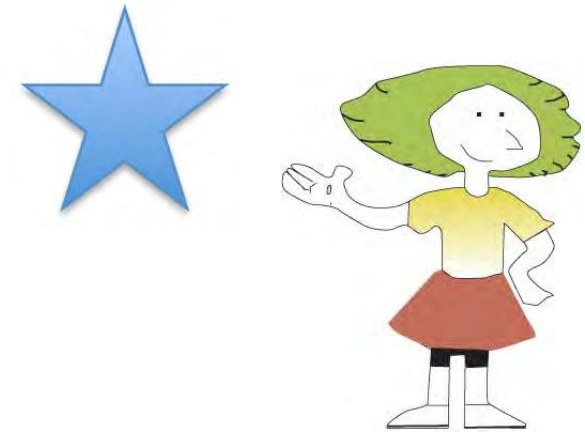
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Describe

give an account (written or spoken) of a situation, event, pattern or process,

or

of the characteristics or features of something.



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Objectives

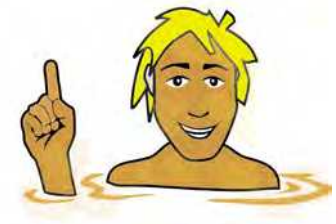
1. Define connectivity.

2. Use the example of a Queensland mangrove jack, to illustrate the implications of connectivity in a marine ecosystem under the following headings:

a. Time and tide

b. Adjacent and distant habitat migration

c. Implications for species survival



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For example

Element	Explanation
Time and tide	As the tide comes feeding patterns change. Larval fish migrate between patches of prey, adults feed or escape predators, juveniles search for a suitable estuary or searching for a particular sub-habitat. Mangrove Jack migrate during tides to feed. This can also vary over the month as dictated by the moon. Currents also affect where the fish can live.
Adjacent and distant habitat migration	Habitats are now being grouped when discussing connectivity. Terms such as the ecosystem mosaic (CEM) are being used to describe tightly interlinked coastal, estuarine, saltmarsh and freshwater habitats at the interface of land and sea. Young mangrove jack live in freshwater, river estuaries and coastal habitats hiding in rocky banks and under tree branches at the waters edge. Older fish move downstream into estuaries and mangroves. Adults move offshore to breed and spawn. Fish larvae are then transported back into estuaries where they swim back to their freshwater and brackish water nurseries.
Implications for species survival	Connectivity within and between protected areas is important for maintaining diversity, fish stocks, and especially important for maintaining ecological resilience.

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Mangrove Jack in a local estuary.



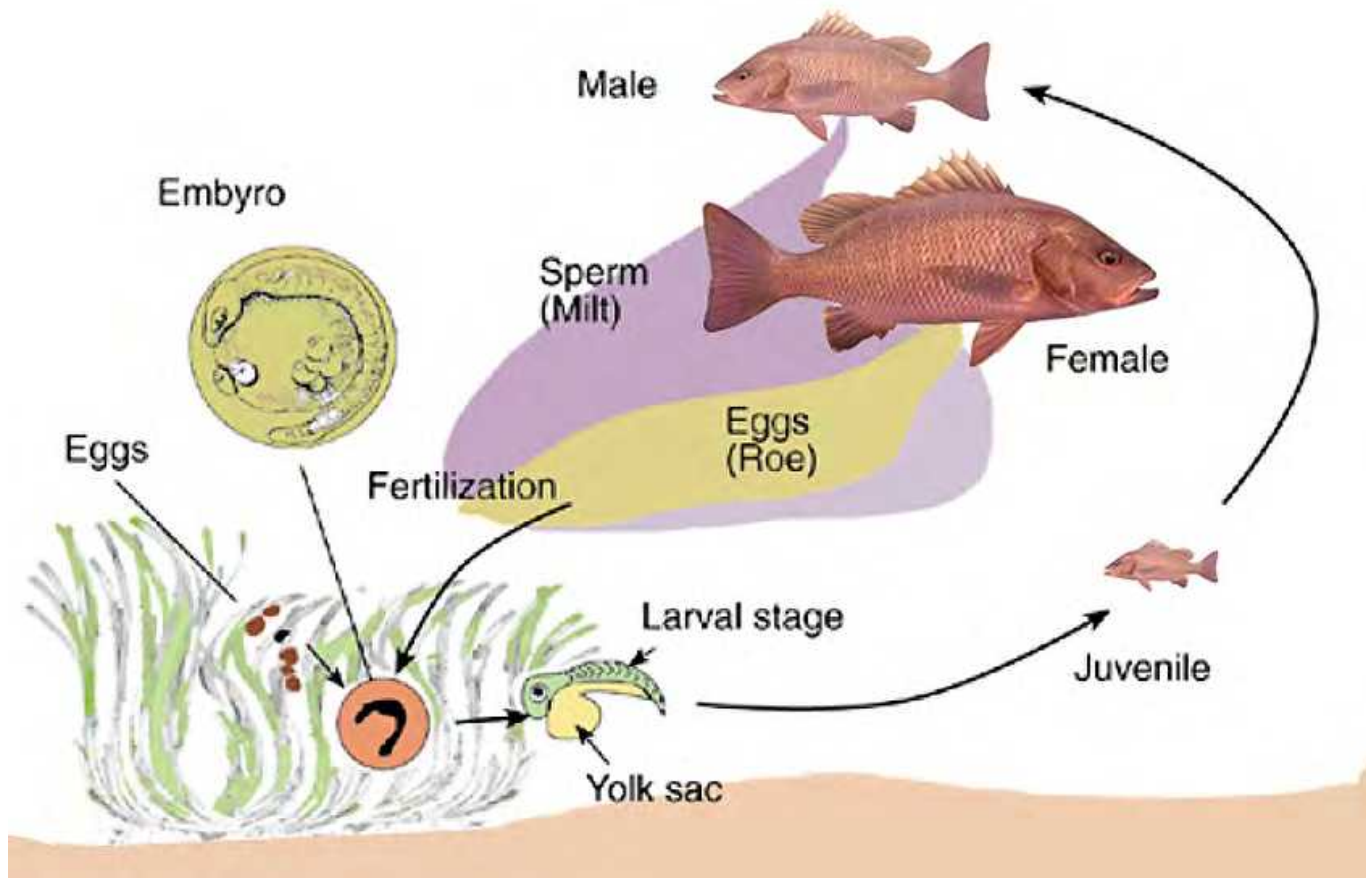
Read the article by Cody Hochen.

http://www.fishandboat.com.au/articles/item/271-gold-coast-jacks-cody-hochen-2017

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Definition

Connectivity is defined as the extent to which populations are linked by the exchange of eggs, larval recruits, juveniles or adults as well as ecological linkages associated with adjacent and distant habitats over time.

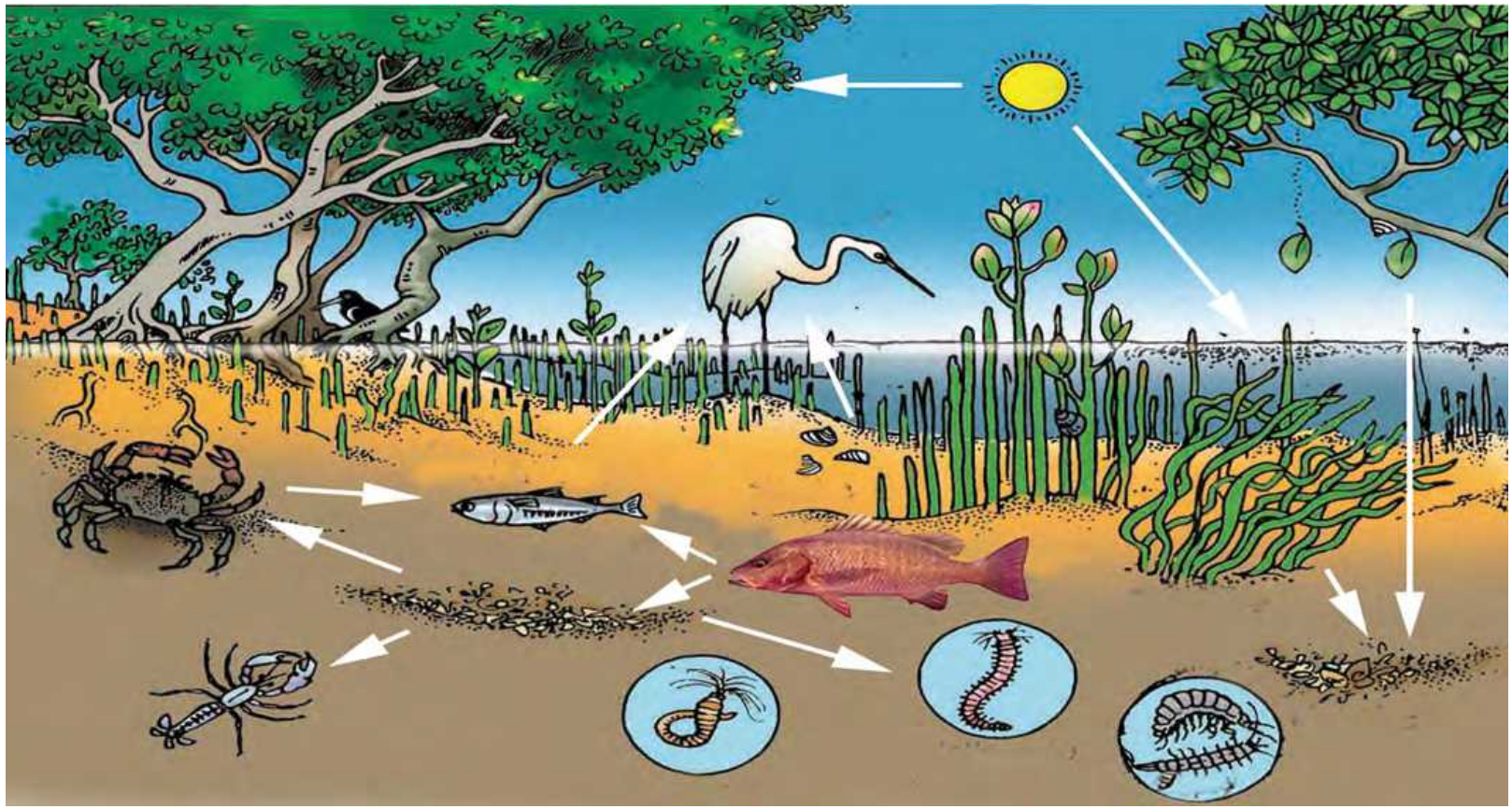


Kerry Kitzelman
REF:
http://www.reefresilience.org/coral-reefs/resilient-mpa-design/connectivity/

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Time and tide

As the tide comes, feeding patterns change. Larval fish migrate between patches of prey, adults feed or escape predators, juveniles search for a suitable estuary or searching for a particular sub-habitat.

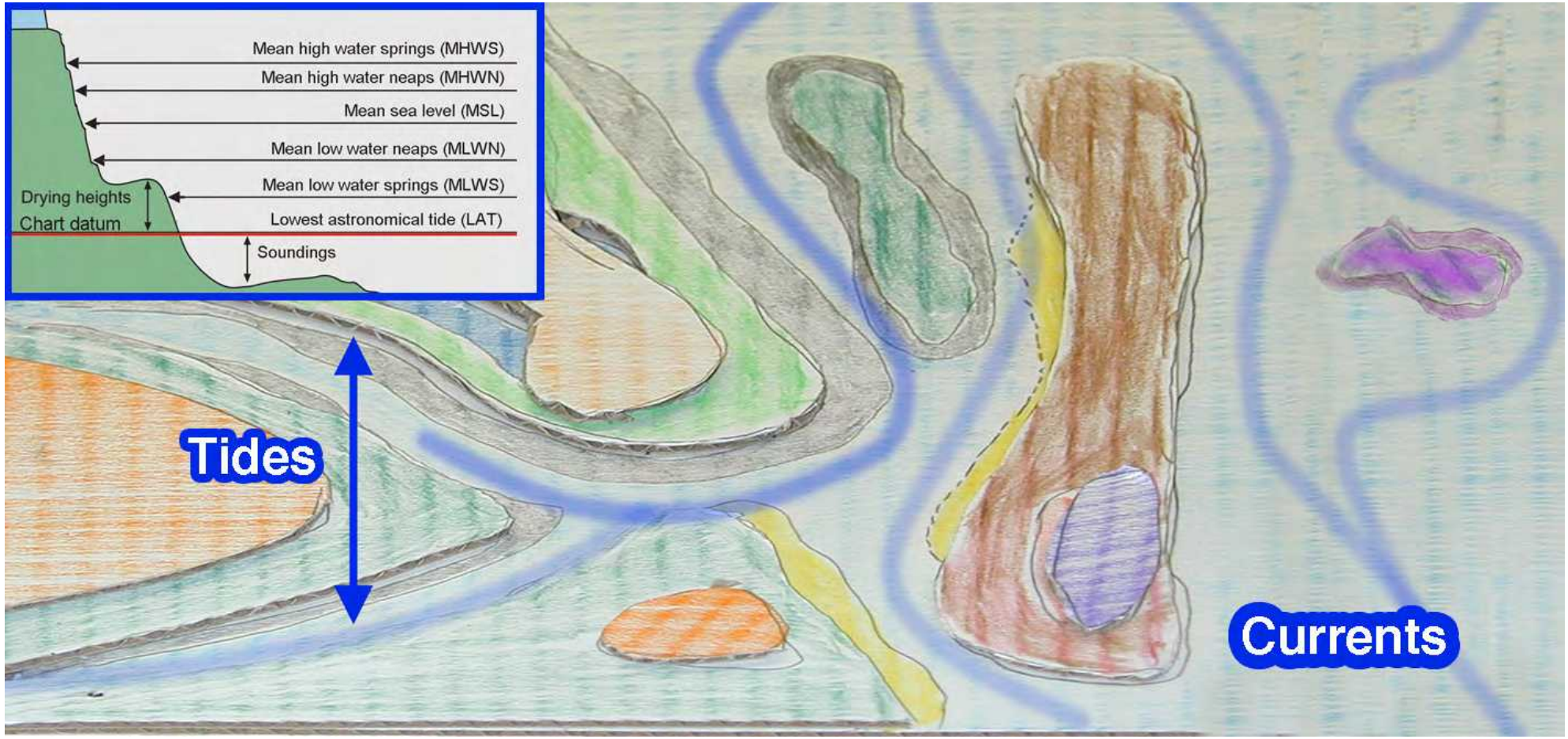


Mangrove Jack in food web

Kerry Kitzelman

© Wet Paper Publications

Mangrove Jack migrate during tides to feed. This can also vary over the month as dictated by the moon. Currents also affect where the fish can live.



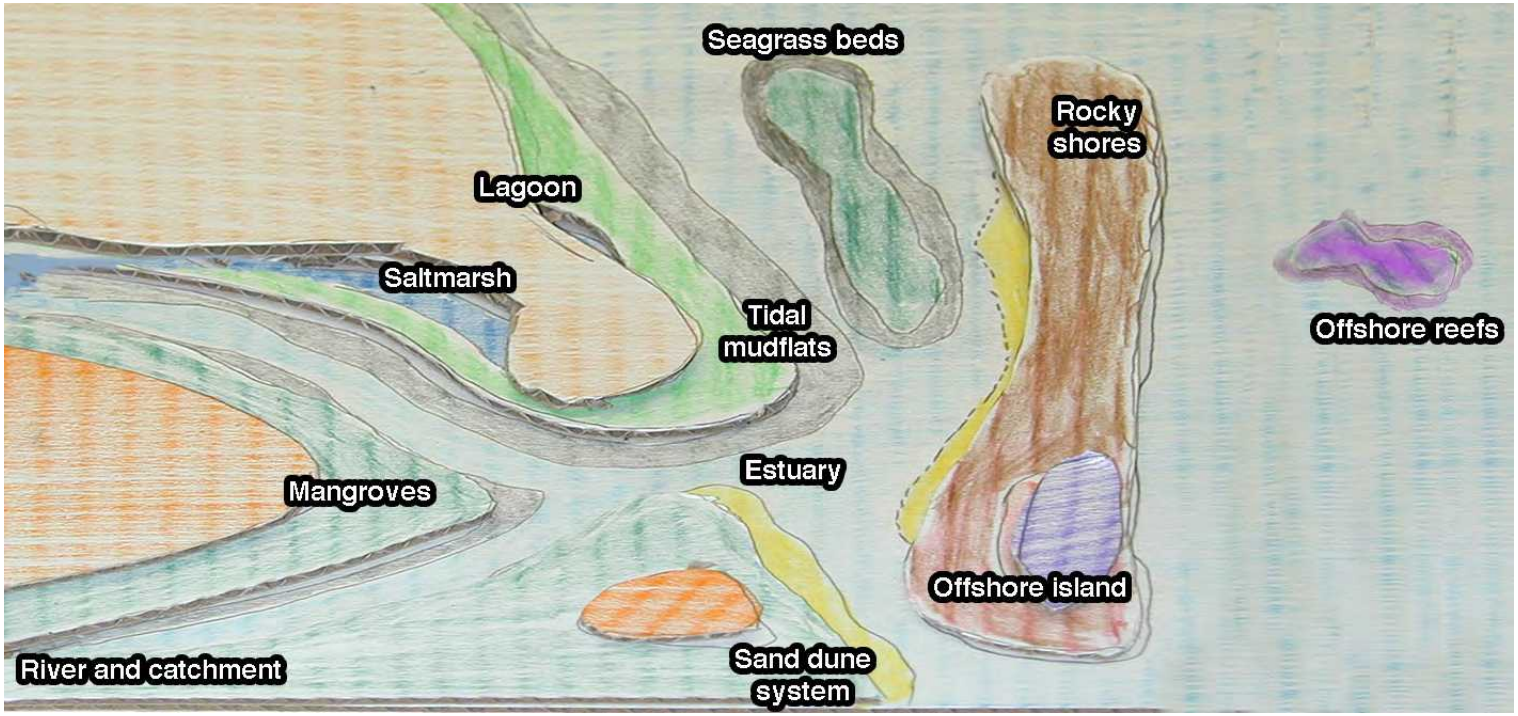
Reef connectivity tides and currents model

Bob Moffatt

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Adjacent and distant habitats

Habitats are now being grouped when discussing connectivity. Terms such as the ecosystem mosaic (CEM) are being used to describe tightly interlinked coastal, estuarine, saltmarsh and freshwater habitats at the interface of land and sea.



Reef connectivity CEM model

Illustration Bob Moffatt

© Wet Paper Publications

Saltmarsh



© Wet Paper Publications

Tidal mudflat



© Wet Paper Publications

Young mangrove jack live in freshwater, river estuaries and coastal habitats hiding in rocky banks and under tree branches at the waters edge. Older fish move downstream into estuaries and mangroves.



Mangrove Jack habitats
Bob Moffatt

© Wet Paper Publications

Adults move offshore to breed and spawn.

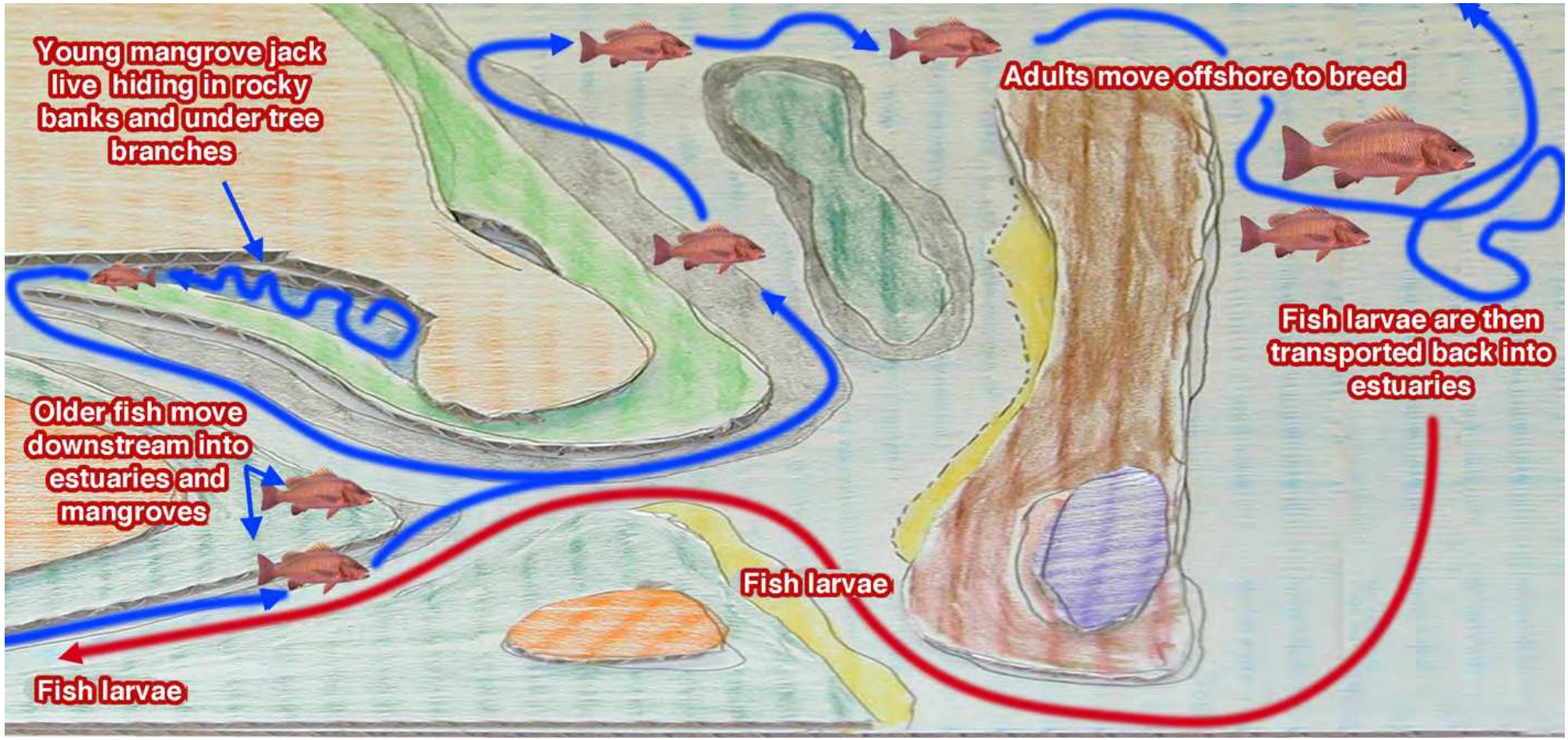


Mangrove Jack migration out to sea

Bob Moffatt Kerry Kitzelman

© Wet Paper Publications

Fish larvae are then transported back into estuaries where they swim back to their freshwater and brackish water nurseries.



Mangrove Jack life cycle model

Bob Moffatt

© Wet Paper Publications

Implications for species survival

Connectivity within and between protected areas is important for maintaining diversity, fish stocks, and especially important for maintaining ecological resilience.

The mangrove jack can only survive if the creek allows a permanent connection between the sea and the mangrove habitat.



Image Google Earth Modified Bob Moffatt

© Wet Paper Publications

The ability of an ecosystem to maintain key functions and processes in the face of stressors or pressures, either by resisting or adapting to change is called its resilience (discussed in Topic 44).



Fish in a school with Mangrove Jack

Murray Waite and NSW Fisheries

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However, for the creek ecosystem to continue to provide connections between the sea and the mangroves, it needs to meet a whole range of requirements, (discussed in next topic).

A. Natural hazard

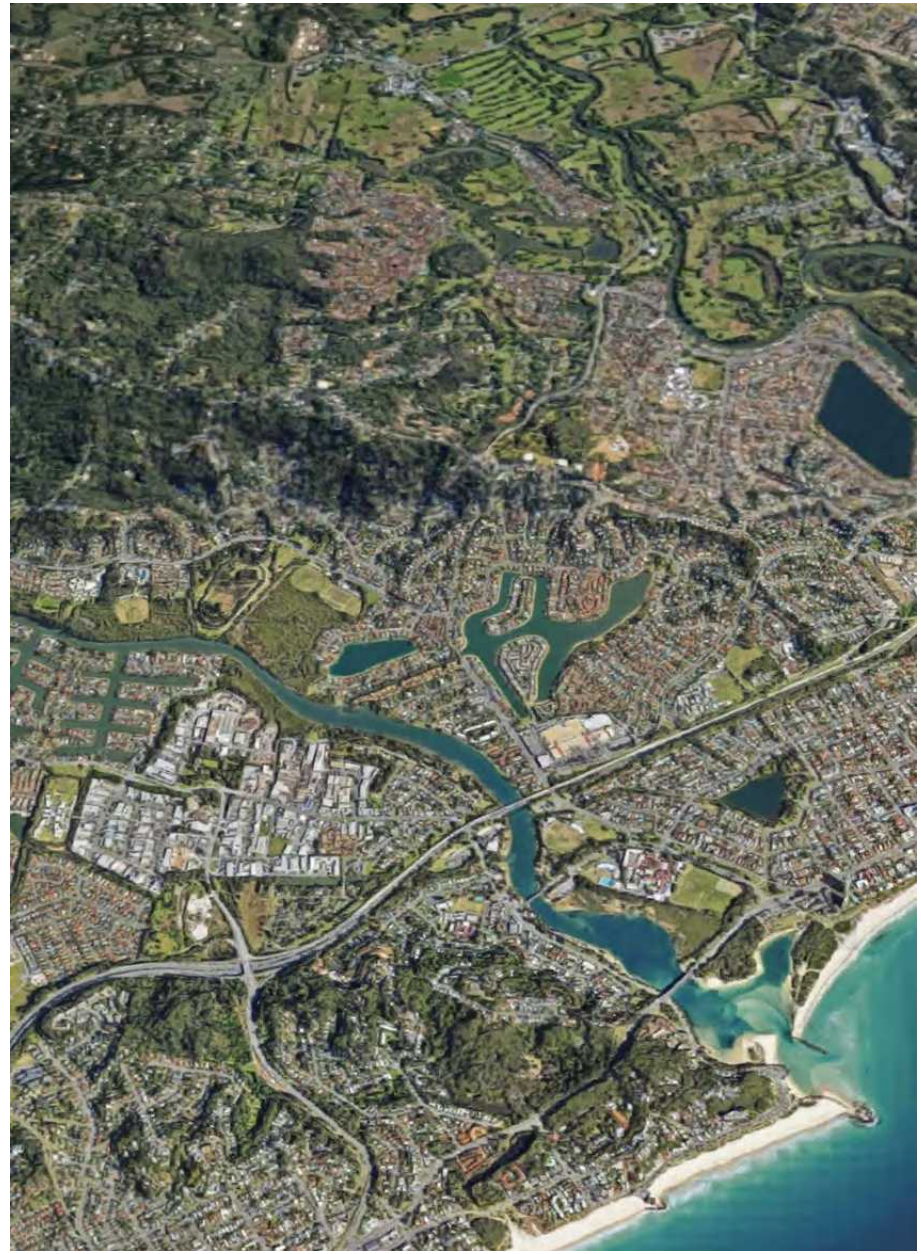
B. Loss/fragmentation of habitat

C. Pollution

D. Over exploitation

E. Introduction of new species

F. Disease



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Questions

1. Define connectivity
2. Complete the following table to show how the three factors listed affect the survival of a Mangrove Jack

Element	Explanation
Time and tide	
Adjacent and distant habitat migration	
Implications for species survival	

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T041 Diversity loss factors



Bob Moffatt

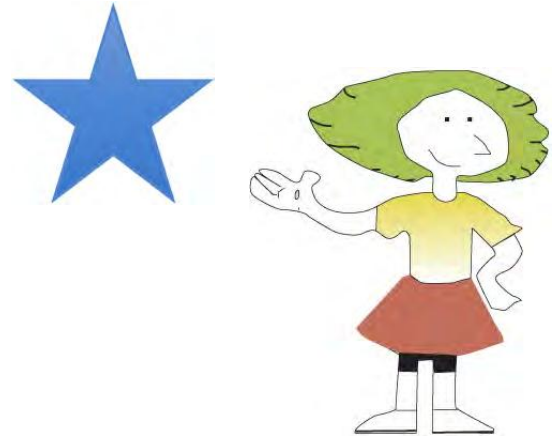
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Syllabus statement

At the end of this topic you should be able to ...

Identify

factors that lead to a loss of diversity (e.g. natural hazard, loss/fragmentation of habitat, pollution, exploitation, introduction of new species, disease).



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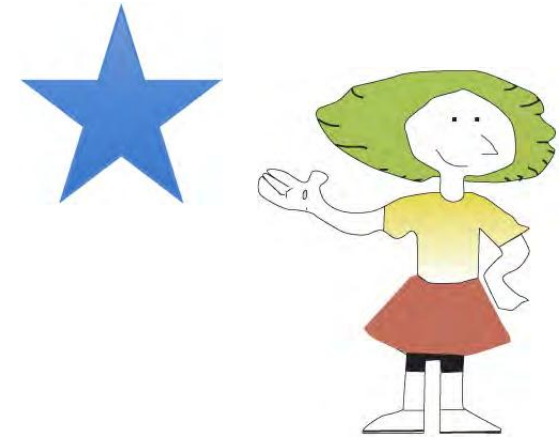
Identify

Locate, recognise and name;

Establish or indicate who or what someone or something is;

Provide an answer from a number of possibilities;

Recognise and **state** a distinguishing factor or feature



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Objective

State how each of the terms listed below contribute to diversity loss giving examples of each.

A. Natural hazard

B. Loss/fragmentation of habitat

C. Pollution

D. Over exploitation

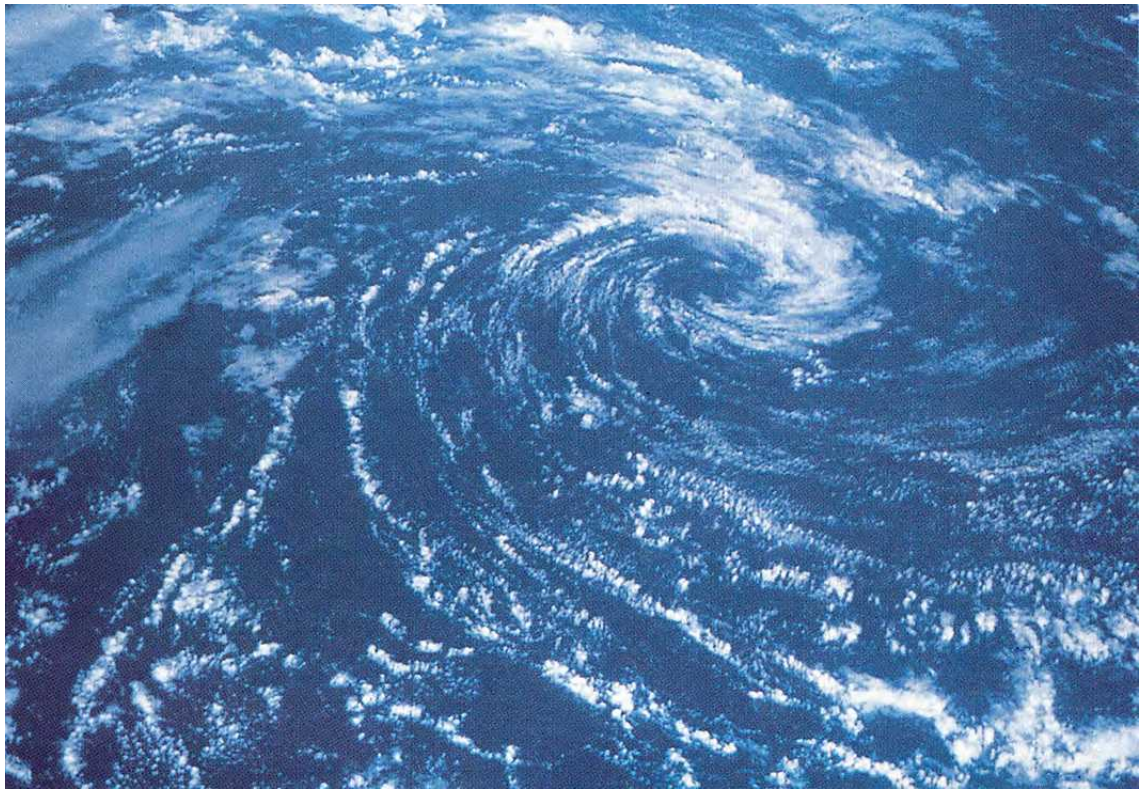
E. Introduction of new species

F. Disease

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Natural hazard

A natural hazard is a natural phenomenon that might have a negative effect on humans or the environment and can be classified into two broad categories - geophysical and biological.





Large storm waves crash on an exposed shore

Credit Bureau of Meteorology

© Wet Paper Publications

Geophysical hazards encompass geological and meteorological phenomena such as earthquakes, volcanic eruptions, wildfires, cyclonic storms, floods, droughts, and landslides. Beach erosion from a large storm is an example altering diversity.



Beach erosion Lady Elliott Island
Bob Moffatt

© Wet Paper Publications

These geophysical hazards can fragment habitats lowering biodiversity.



Whitehaven Beach after Cyclone Debbie

Credit: ABC News Isabella Higgins

© Wet Paper Publications

Many geophysical hazards are related.
For example, submarine earthquakes can cause tsunamis, cyclones can lead to coastal flooding and erosion, and climate change leads to increased sea temperatures.

Loss of diversity can be long term and individual species, such as corals, may or may not recover to the original levels.



Acropora at English Wikipedia [CC BY-SA 3.0 (https://creativecommons.org/licenses/by-sa/3.0)], via Wikimedia Commons
https://upload.wikimedia.org/wikipedia/commons/2/21/Bleachedcoral.jpg

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Cyclones or severe storms can devastate creek riparian vegetation and seriously change water quality .



Flooding Currumbin Creek (Cyclone Debbie 2017)

© Wet Paper Publications

Fragmentation of habitat

Habitat fragmentation describes the emergence of discontinuities (fragmentation) in an organism's preferred environment (habitat), causing population fragmentation and ecosystem decay.

Roads are an excellent terrestrial example.



Habitat fragmentation roads
Murray Waite

© Wet Paper Publications

This is more difficult to see in the marine world



Habitat fragmentation marinas

Photo Murray Waite

© Wet Paper Publications

Habitats that were once in close proximity have now been separated into smaller isolated areas decreasing all aspects of diversity.



Habitat fragmentation canals

Photo Murray Waite

© Wet Paper Publications

Marinas, bridges, pontoons, rock walls used to control erosion, deforestation and land clearing are some ways habitats can become fragmented.



Habitat fragmentation by bridges

Photo Bob Moffatt

© Wet Paper Publications

Housing estates built in riparian vegetation also contribute to fragmentation of habitat.



Habitat fragmentation by housing

Photo Bob Moffatt

© Wet Paper Publications

Habitat fragmentation caused by climate change can alter the environment much faster and threatens extinctions of many species.

For example, Polar bears habitats.



Polar bear on ice

By USGS - https://alaska.usgs.gov/science/biology/polar_bears/size.html, Public Domain, https://commons.wikimedia.org/w/index.php?curid=3937686

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A key danger posed by climate change is malnutrition or starvation due to habitat loss. Polar bears hunt seals from a platform of sea ice, this becomes more difficult with habitat fragmentation.



Polar bear with prey

By AWeith - Own work, CC BY-SA 4.0,
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Rising temperatures causes sea ice to melt earlier in the year, driving the bears to shore before they have built sufficient fat reserves to survive the period of scarce food in the late summer and early fall.



Polar bear on ice

By Alan Wilson - www.naturespicsonline.com: [1], CC BY-SA 3.0,
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Reduction in sea-ice cover also forces bears to swim longer distances, which further depletes their energy stores and occasionally leads to drowning.



Polar bear swimming

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Thinner sea ice tends to deform more easily, which appears to make it more difficult for polar bears to access seals.



Polar bear

By Arturo de Frias Marques [CC BY-SA 4.0 (https://creativecommons.org/licenses/by-sa/4.0)], from Wikimedia Commons
https://upload.wikimedia.org/wikipedia/commons/3/3d/Polar_Bear_AdF.jpg

© Wet Paper Publications

Insufficient nourishment leads to lower reproductive rates in adult females and lower survival rates in cubs and juvenile bears, in addition to poorer body condition in bears of all ages.



Starving Polar Bear

By Andreas Weith - Own work, CC BY-SA 4.0,
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Pollution

Pollution is the introduction of contaminants into the natural environment that cause adverse change.



Point source pollution

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Major forms of pollution include:

- Light
- Littering
- Noise
- Plastic
- Soil
- Radioactive contamination
- Thermal pollution
- Visual pollution
- Water pollution
- Air pollution



By Frank J. (Frank John) Aleksandrowicz, 1921-, Photographer (NARA record: 8452210) - U.S. National Archives and Records Administration, Public Domain, https://commons.wikimedia.org/w/index.php?curid=17100801

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An example of how pollution contributes to diversity loss is litter.



Litter on a beach

By Nils Ally - Personal trip in 2010, CC BY 3.0, https://commons.wikimedia.org/w/index.php?curid=14730037

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Litter consists of waste products that have been disposed improperly, without consent, at an inappropriate location.

Litter can be aluminium cans, cardboard boxes or plastic bottles on the ground and left there indefinitely or for others to dispose of as opposed to disposing of them properly.



Litter on a street

By Bengt Nyman from Vaxholm, Sweden - originally posted to Flickr as IMG_6064-1, CC BY 2.0, https://commons.wikimedia.org/w/index.php?curid=10777224

© Wet Paper Publications

Eventually, this litter ends up in the sea affecting marine life.



Parks Victoria

© Wet Paper Publications

Digestive systems of marine life are seriously affected.



Whale under tarp Hinchinbrook

Credit Qld NP&WLService - Julie Swartz

© Wet Paper Publications

Litter in the stomachs of marine life causes great stress as digestion cannot properly occur.





Whale dying and dead

Credit Qld NP&WLService - Julie Swartz

© Wet Paper Publications

This can be seen from the amount of plastic that is removed from a dead whale.



Plastic from a dead whale's stomach

Credit Qld NP&WLService - Julie Swartz

© Wet Paper Publications

Over exploitation

Over-exploitation refers to harvesting a renewable resource to the point of diminishing returns.

Continued overexploitation can lead to the destruction of the resource and prevent future generations from exploiting it

In ecology, over-exploitation is one of the five main activities threatening global biodiversity.

Example:

Atlantic cod



By The original uploader was Jom at German Wikipedia. - Joachim Müllerchen, CC BY-SA 2.0 de, https://commons.wikimedia.org/w/index.php?curid=4031466

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Atlantic cod, juvenile.

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They are a fine eating fish for European markets making them a target species.

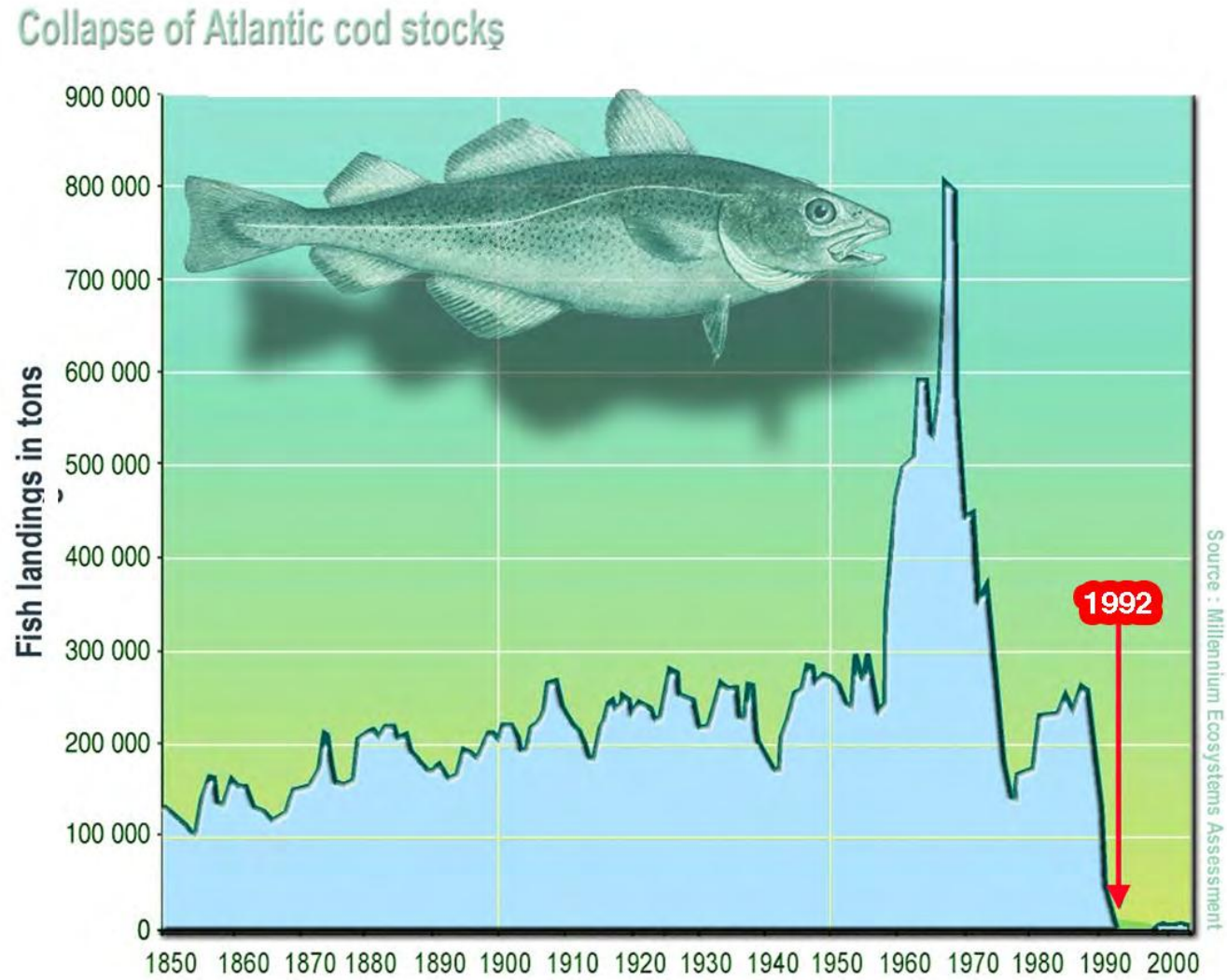


Atlantic cod fillets

Foto: Jonn Leffmann [CC BY 3.0 (https://creativecommons.org/licenses/by/3.0)], from Wikimedia Commons
https://upload.wikimedia.org/wikipedia/commons/2/27/Torskfil%C3%A9_%28Gadus_morhua%29_-_Ystad-2017.jpg

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Atlantic cod stocks were severely over-exploited in the 1970s and 1980s, leading to their abrupt collapse in 1992.



Atlantic cod collapse graph

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This collapse resulted in a >95% of reduction in biomass and have failed to fully recover even with the cessation of fishing.

This absence of **the apex predator** has led to what is called a biodiversity trophic cascade in many ocean areas.



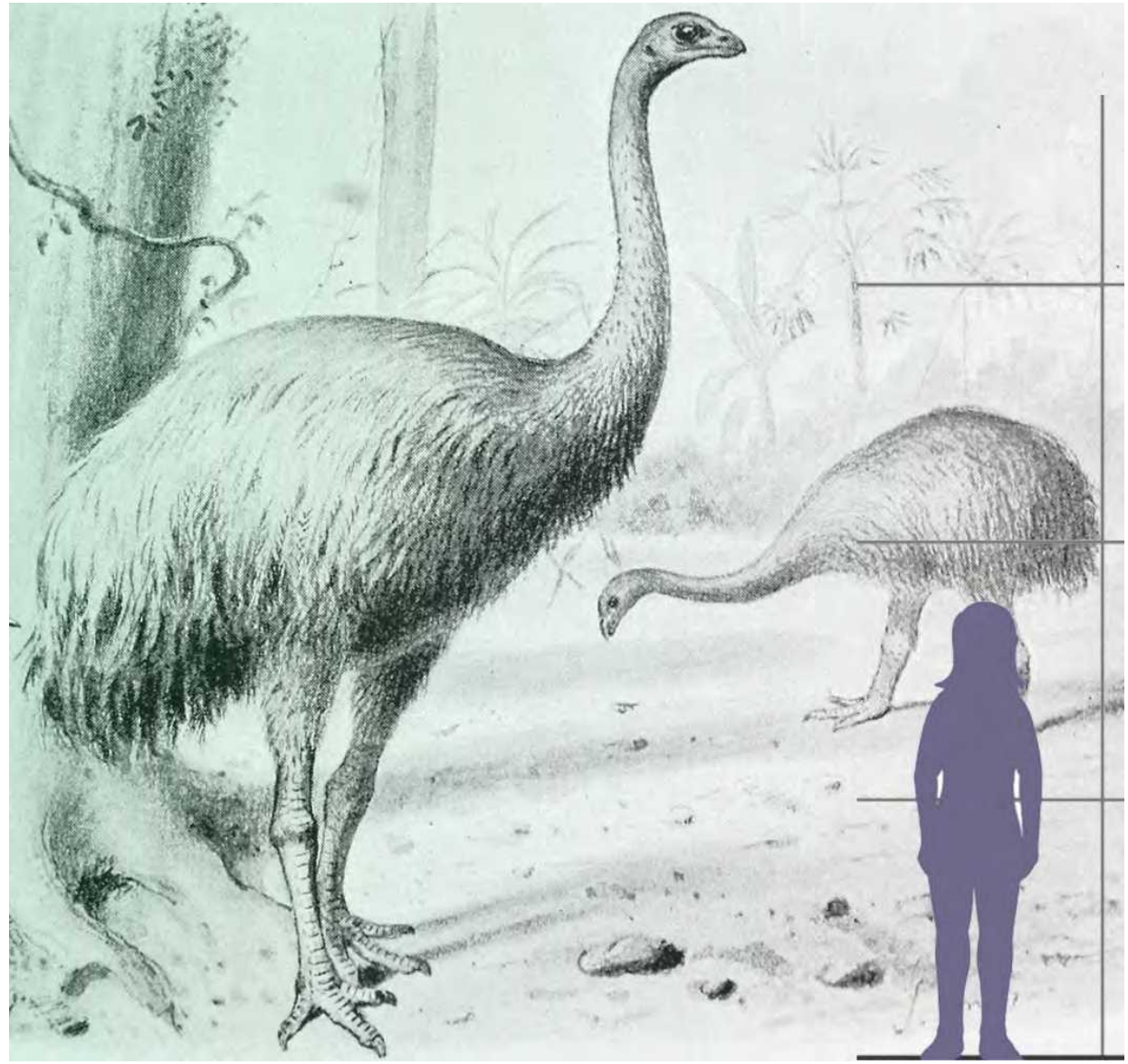
Atlantic cod range

By I, Aotearoa, CC BY-SA 3.0, https://commons.wikimedia.org/w/index.php?curid=2245573

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A second example of over-exploitation is the Moa bird in New Zealand.

The Moa was flightless bird endemic to New Zealand, reached about 3.6 m (12 ft) in height with neck outstretched, and weighed about 230 kg (510 lb).



Giant moa restoration By http://www.50birds.com/extan/gextanimals10.htm, Public Domain, https://commons.wikimedia.org/w/index.php?curid=4383372

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When Polynesians settled New Zealand about 1280, the moa population was about 58,000 and were hunted only by the Haast's eagle.



Moa and Haast's eagle

By John Megahan - Ancient DNA Tells Story of Giant Eagle Evolution. PLoS Biol 3(1): e20. doi:10.1371/journal.pbio.0030020.g001, CC BY 2.5, https://commons.wikimedia.org/w/index.php?curid=52877

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Within 25 years, the Moa was extinct primarily due to overhunting by Māori and within a few years, so was Haast's eagle.





Moa skeleton and footprints and restoration

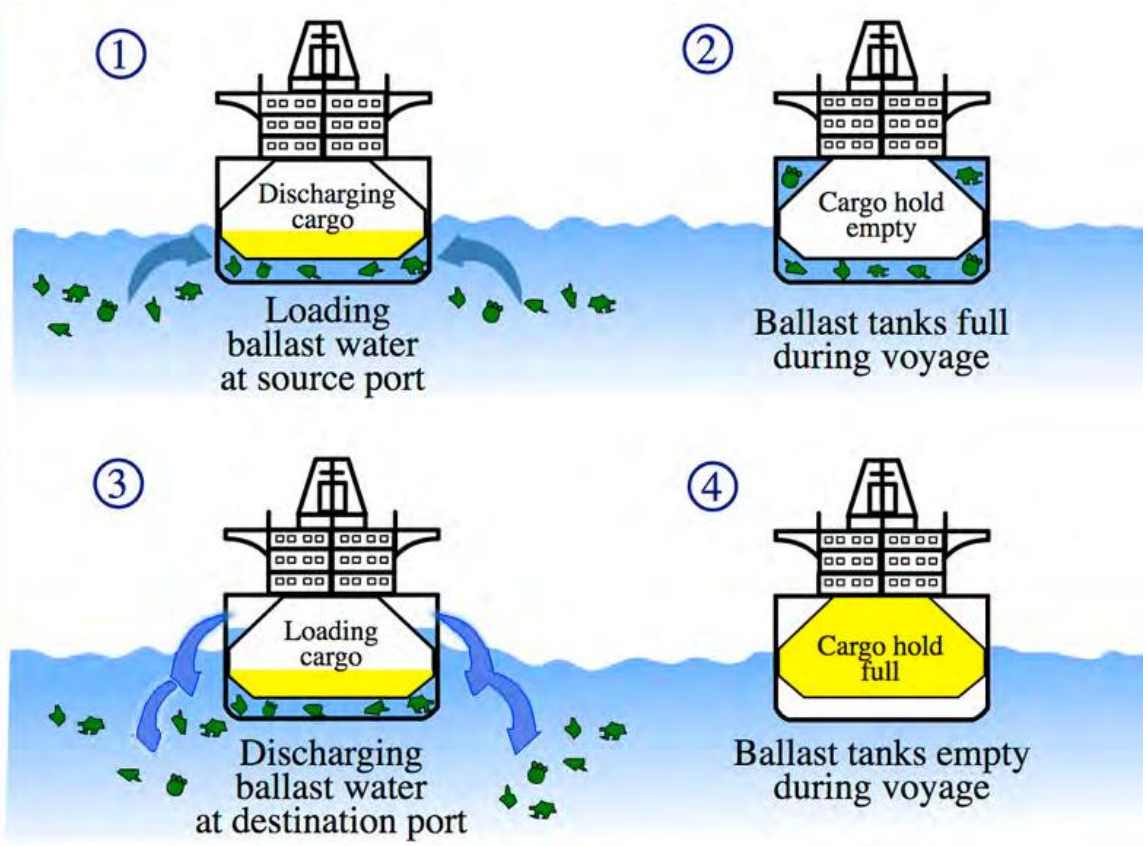
Skeleton - By Natural History Museum, London - Natural History Museum data portal, CC BY 4.0, https://commons.wikimedia.org/w/index.php?curid=65291711
Footprints - By K. Wilson - http://rsnz.natlib.govt.nz/image/rsnz_45/rsnz_45_00_0229_0000f_ac_01.html, Public Domain, https://commons.wikimedia.org/w/index.php?curid=4571671
Restoration - By George Edward Lodge - https://archive.org/details/extinctbirdsatte00roth), PD-US, https://en.wikipedia.org/w/index.php?curid=34354385

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Introduction of new species by ballast water

Ballast water consists of water that is taken on board a ship for the enhancement of the ship's stability at sea.



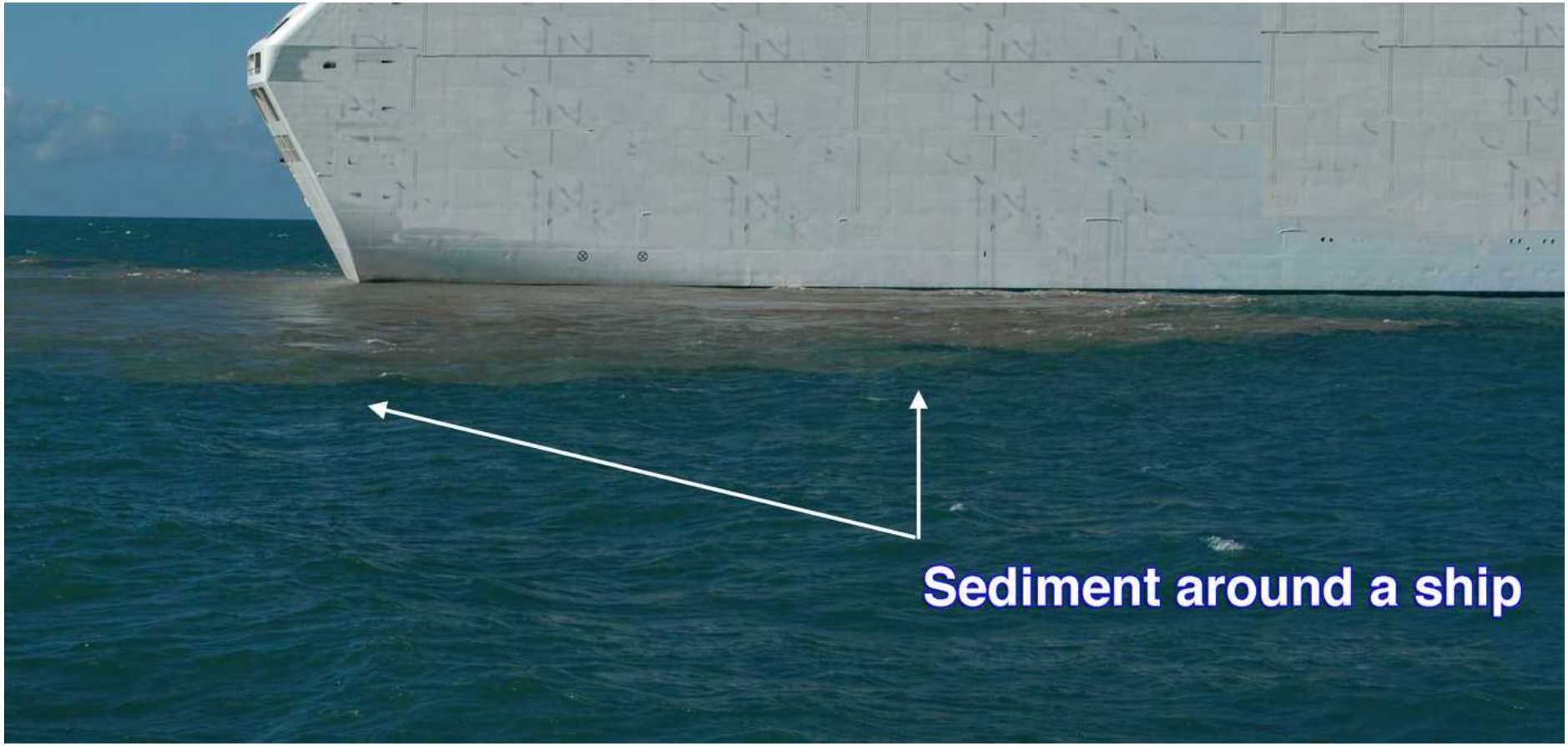


Ballast water on a ship

By Original: MaxxLDerivative work: Thorsten Hartmann - File:Water pollution by ballast water de.svg, CC BY-SA 3.0, https://commons.wikimedia.org/w/index.php?curid=33556135

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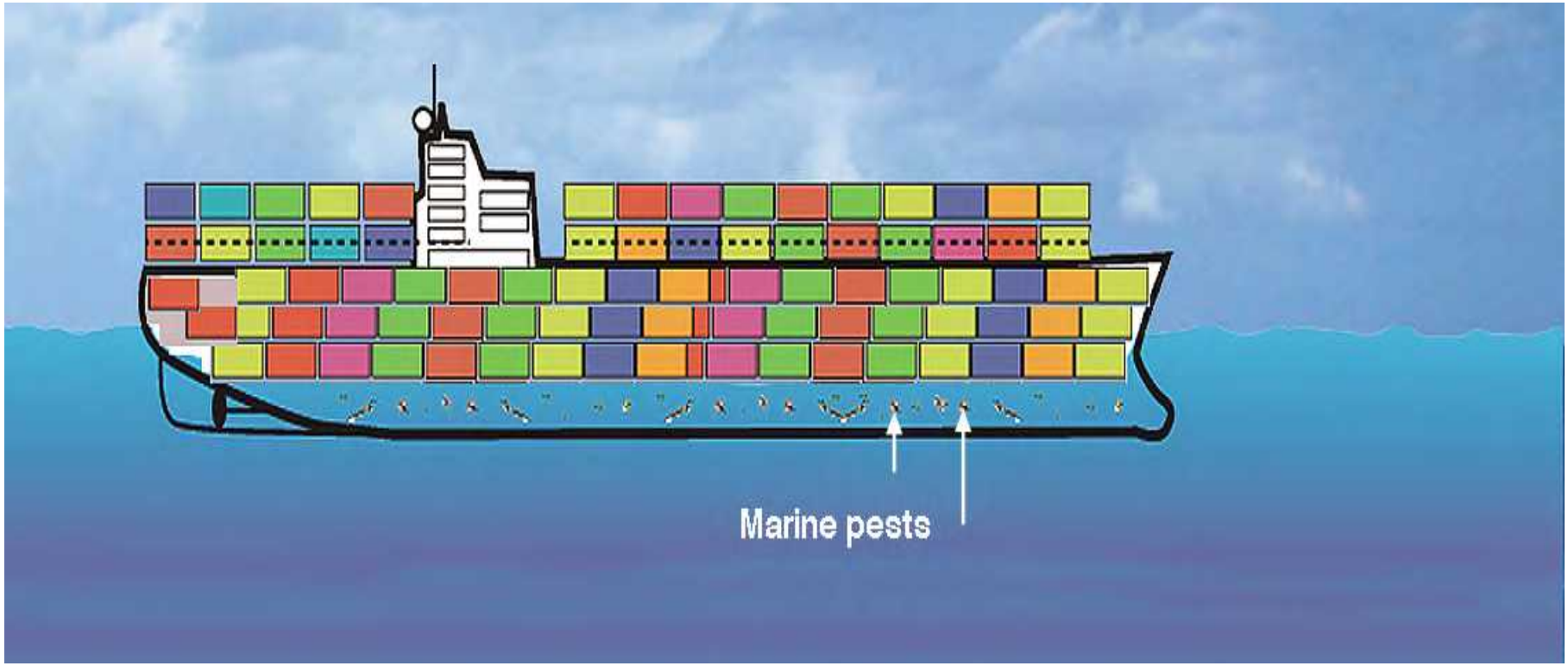
Ballast water may contain sediment if it is taken on whilst the ship is in shallow or turbid water.



Sediment around a ship
Bob Moffatt

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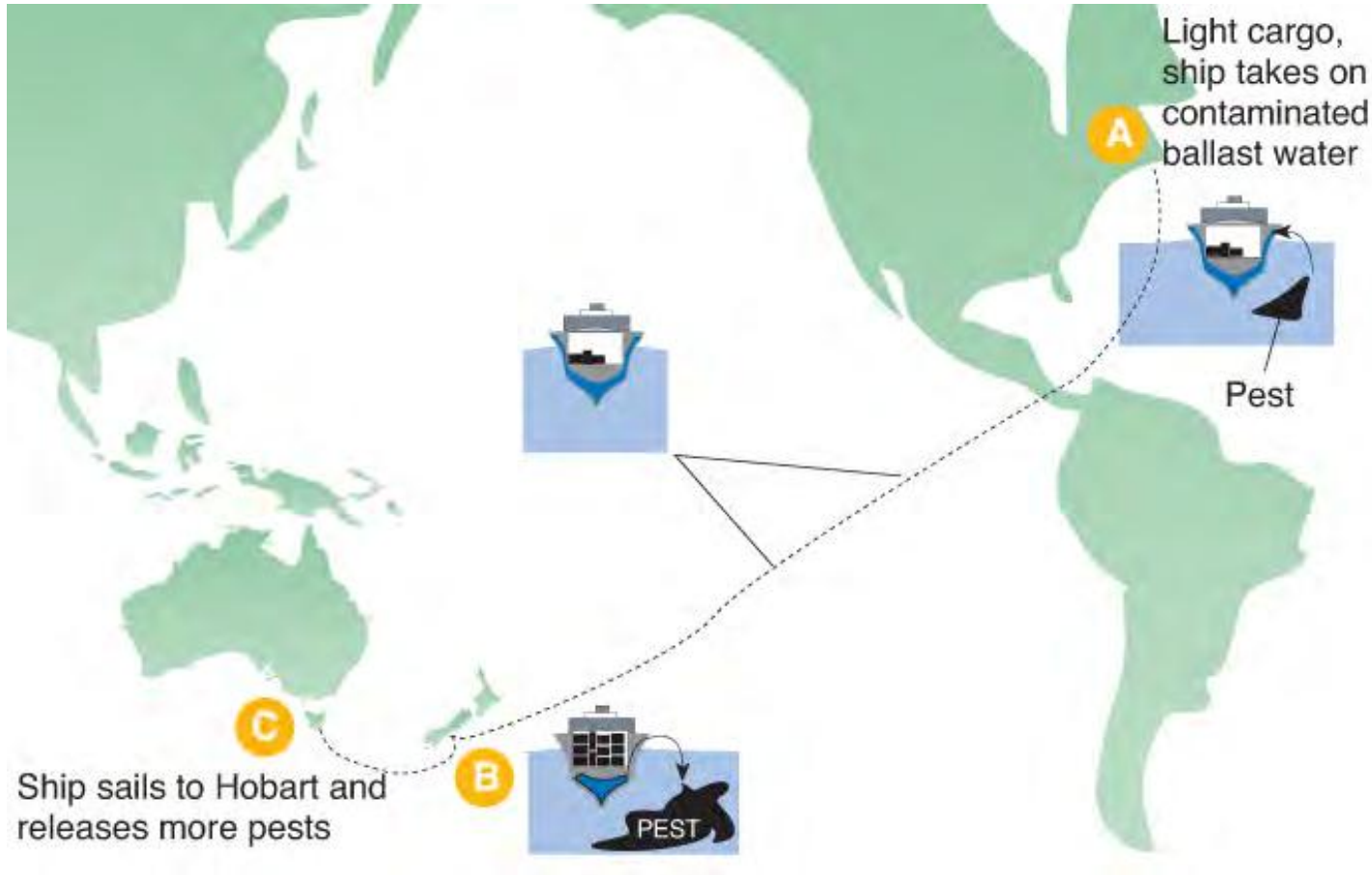
These sediments and the water can contain a wide range of live marine and estuarine flora and fauna.



Ship ballast with pests
Bob Moffatt

© Wet Paper Publications

These are then transported away from their original source and discharged into the destination port as the ship is loaded with cargo.



Ship with ballast and pests map
Bob Moffatt

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The Northern Pacific seastar, (Asterias amurensis) is an invasive species in Australia.

The seastar is native to the coasts of northern China, North Korea, South Korea, Russia and Japan and distribution of this species into other countries has increased.



Northern Pacific starfish

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It is on the Invasive Species Specialist Group list of the world's 100 worst invasive species and is a major competitor, threatening the biodiversity of endemic (native) species. It can breed prolifically outnumbering our native species and eats almost anything.

Not logged in Talk Contri

Article Talk Read Edit View history Search Wikipedia

List of globally invasive species

From Wikipedia, the free encyclopedia

This is a list of 100 of the "worst" invasive species in the Global Invasive Species Database, as of 2014.[1] The IUCN Invasive Species Specialist Group (ISSG), which maintains the list, acknowledges that it is "very difficult to identify 100 invasive species from around the world that really are 'worse' than any others."[1]

Contents [hide]

1 Criteria for inclusion
2 100 of the World's Worst Invasive Species
3 See also
4 References
5 External links

Criteria for inclusion [edit]

Two criteria were used in selecting items for the list (Homo Sapiens being excluded):

- An invasive species' "serious impact on biological diversity and/or human activities"; and
- That species' "illustration of important issues surrounding biological invasion".[1]

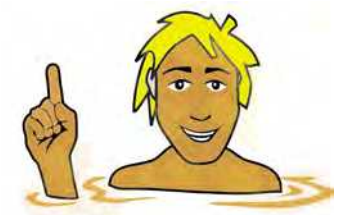
According to the ISSG, "only one species from each genus was selected."[1]

100 of the World's Worst Invasive Species [edit]

Species	Type	Common names	Notes[2]
Acacia mearnsii	shrub	**Black wattle**, Australian acacia	Invasive worldwide. Native to Australia.
Acridotheres tristis	bird	**Common myna**, Calcutta myna, house myna, Indian myna, *martin triste*, talking myna	Invasive in Australia, Hawaii, and Fiji. Native to South Asia.
Aedes albopictus	insect	**Asian tiger mosquito**, forest day mosquito, tiger mosquito	Spread via the international tire trade. Native to tropical Asia.
Anopheles quadrimaculatus	insect	**Common malaria mosquito**	Invasive in North America.
Anoplolepis gracilipes	insect	**Yellow crazy ant**, crazy ant, gramang ant, long-legged ant, Maldive ant	Invasive in Hawaii and Indian Ocean islands.
Anoplophora glabripennis	insect	**Asian long-horned beetle**, starry sky beetle	Invasive in North America and established and potentially invasive in parts of Europe. Native to East Asia.
Aphanomyces astaci	protozoan	**Crayfish plague**	Invasive in Europe. Native to North America.
Ardisia elliptica	tree	**Shoebutton Ardisia**	Invasive in tropical Australia, South Florida, the Caribbean and many Pacific and Indian Ocean islands. Native to South and Southeast Asia.
Arundo donax	grass	**Giant cane**, arundo grass, bamboo reed, cane, cow cane, donax cane, giant reed, reedgrass, river cane, Spanish cane, Spanish reed, wild cane	Invasive in California.
Asterias amurensis	starfish	**Northern Pacific seastar**, flatbottom seastar, Japanese seastar, Japanese starfish, North Pacific seastar, purple-orange seastar	Invasive in the southern coasts of Australia. Native to far north Pacific Ocean coasts.
Banana bunchy top virus (BBTV)	virus	**Banana bunchy top disease**, BBTD, abaca bunchy top virus, BBTV, bunchy top, bunchy top virus	Invasive worldwide.
Batrachochytrium dendrobatidis	fungus	"Bd," chytrid frog fungi, chytridiomycosis, frog chytrid fungus	Invasive in Australia and Panama.

Reference

https://en.wikipedia.org/wiki/List_of_globally_invasive_species



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Disease

An example is the Pandanus.



Pandanus dieback

https://www.sunshinecoastdaily.com.au/news/pandanus-palms-in-battle-for-survival/3222654/

© Wet Paper Publications

Pandanus in Queensland can grow to 20 m typically with a broad canopy, heavy fruit, a stout trunk ringed with many leaf scars and pyramid shaped roots.



Healthy Pandanus
Bob Moffatt

© Wet Paper Publications

A single Pandanus is an ecosystem in itself including

- insects,
- gekos,
- rodents,
- frogs,
- spiders,
- snakes

The tree also provides a water source for birds.

Fallen leaves provide a valuable source of nutrients for the coastal ecosystem as well as habitats for coastal marine life.



In many coastal areas it is considered a keystone species.

Pandanus

Illustration Steven Byers

© Wet Paper Publications

Definition

A disease any abnormal condition in a plant that interferes with its vital physiological processes, caused by pathogenic microorganisms, parasites, unfavorable environmental, genetic or nutritional factors.



Dieback sign coastal plants caused by a fungal disease

By Photographs by Gnangarra...commons.wikimedia.org, CC BY 2.5 au, https://commons.wikimedia.org/w/index.php?curid=1089320

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Over the past few years Pandanus are under threat from dieback.



Pandanus dieback from disease
Bob Moffatt

© Wet Paper Publications

The yellow leaves and broken off crown indicate a disease has taken over this Pandanus.



Bob Moffatt

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This dieback caused by an insect known as the Pandanus planthopper *Jamella australiae*.



Two leafhoppers and juvenile on Pandanas

Credit Joel Fostin and Sunshine Coast ABC news)
https://www.frasercoastchronicle.com.au/news/student-fights-disease-killing-trees-fraesr-island/3135369/

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Planthopper induced dieback is caused by extremely heavy infestations of planthoppers sucking the plant's sap from the leaf sheaths.



Pandanas planthopper Bundaberg.

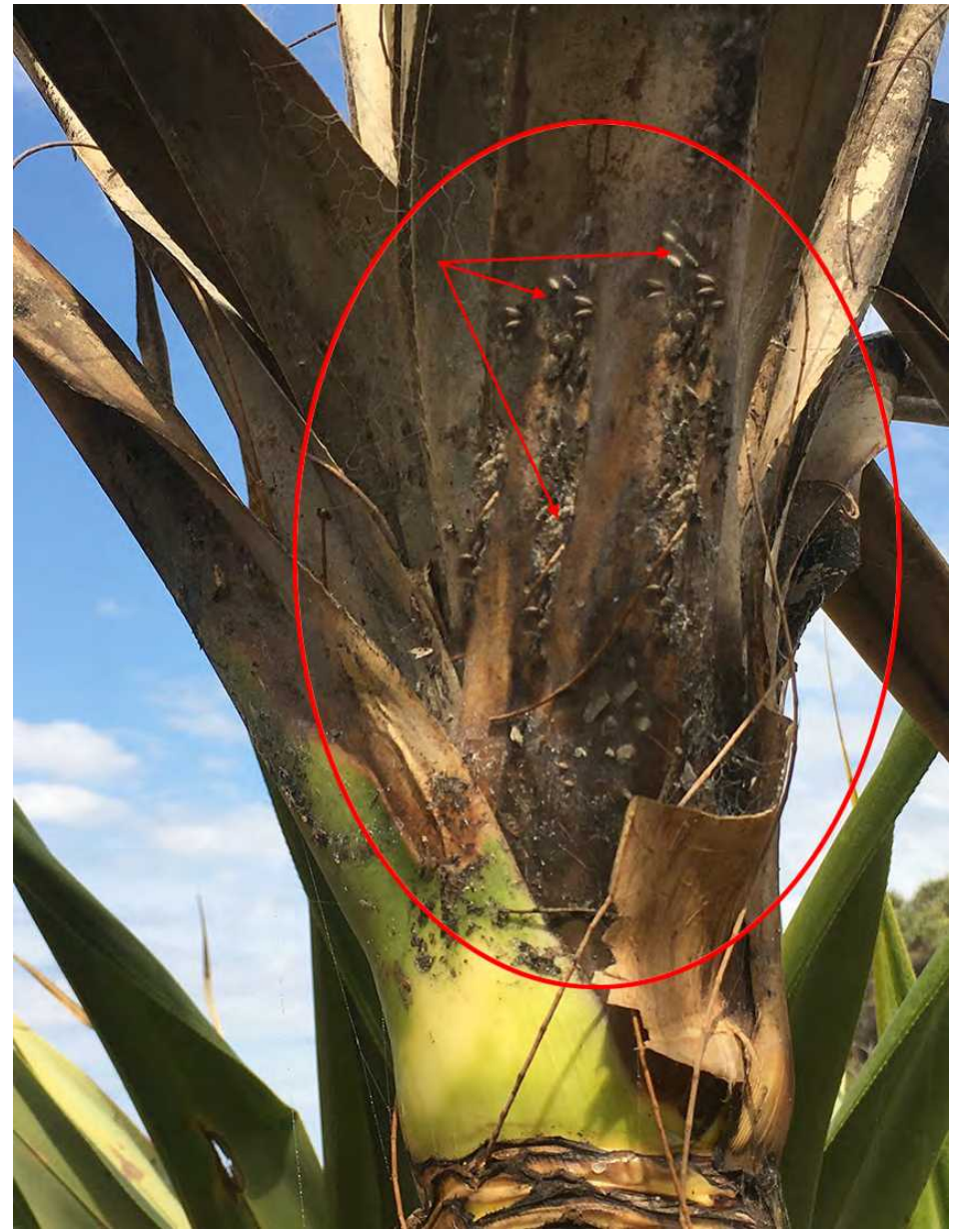
Bundaberg Regional Council

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The planthoppers exude honeydew which encourages mould growth and rotting of terminal growth points.

As planthoppers have a short flight range, spread to new areas is most likely to be caused by the movement of potted and transplanted Pandanus trees within the nursery and landscape industries.

Infestations of the Jamella planthoppers have recently spread to northern NSW



Bob Moffatt

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This combination of health debilitating feeding and life cycle processes results in the overall dieback of the Pandanus trees.



Photo Bob Moffatt (Credit Joel Fostin)

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It is believed the insects were introduced from Northern Queensland by importing Pandanus trees from nurseries.

Because the leaf hopping bug's natural predator (a wasp) cannot live this far south, the leaf hopping bugs had a bug ball.



Pandanas (L diseased, R Healthy)
Bob Moffatt

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Efforts are now being made to save the SE Queensland Pandanas by

- Introducing the natural wasp predator
- Spiking the crown of the plant with a slow release insecticide
- Reducing the leaf hoppers habitat by stripping leaves from the tree

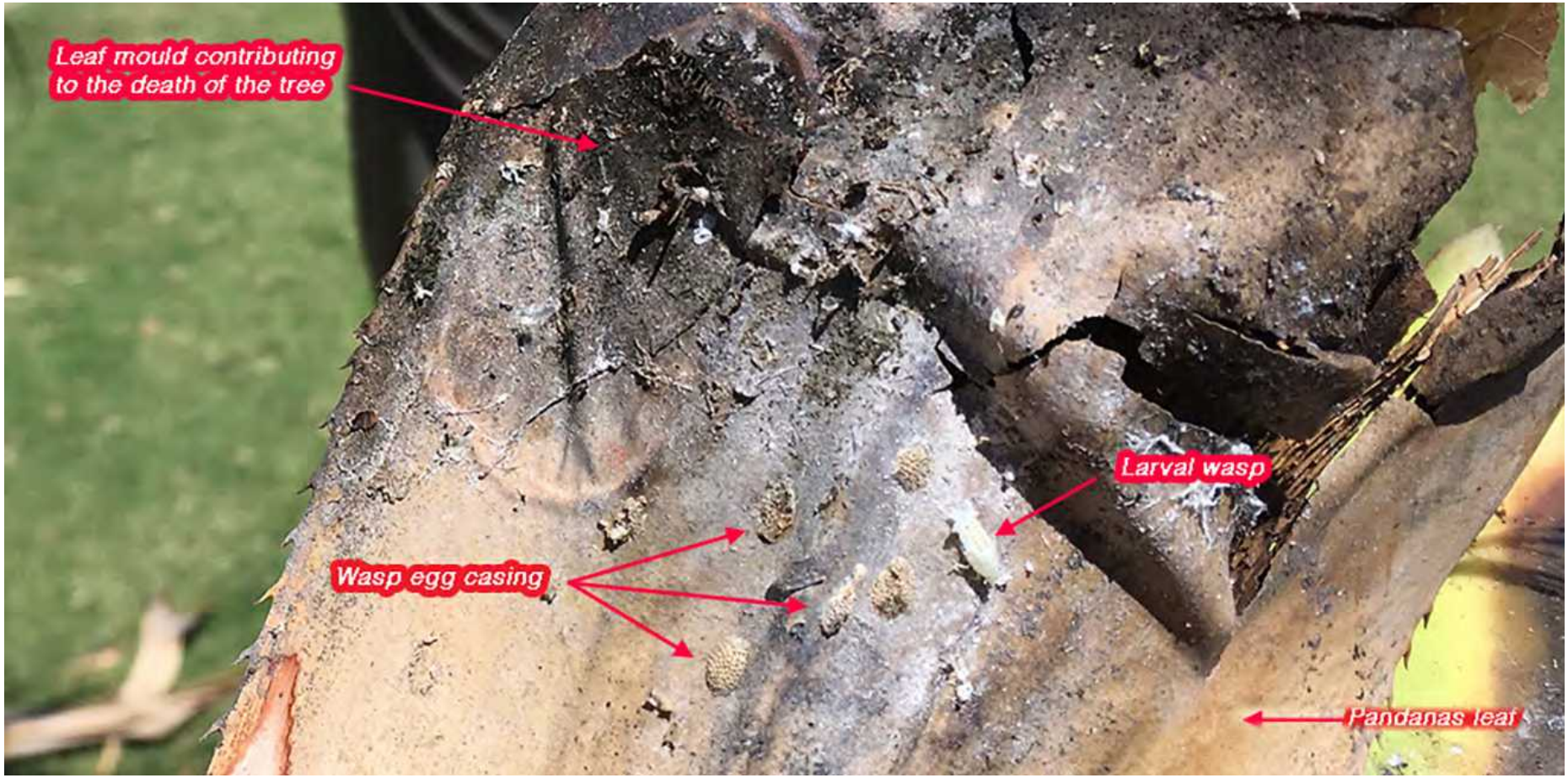


Photo Bob Moffatt (Credit Joel Fostin)

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Manual labour is used to strip off infected leaves.



Photo Bob Moffatt

© Wet Paper Publications

References

You can follow the work of one scientist who is trying to understand the disease

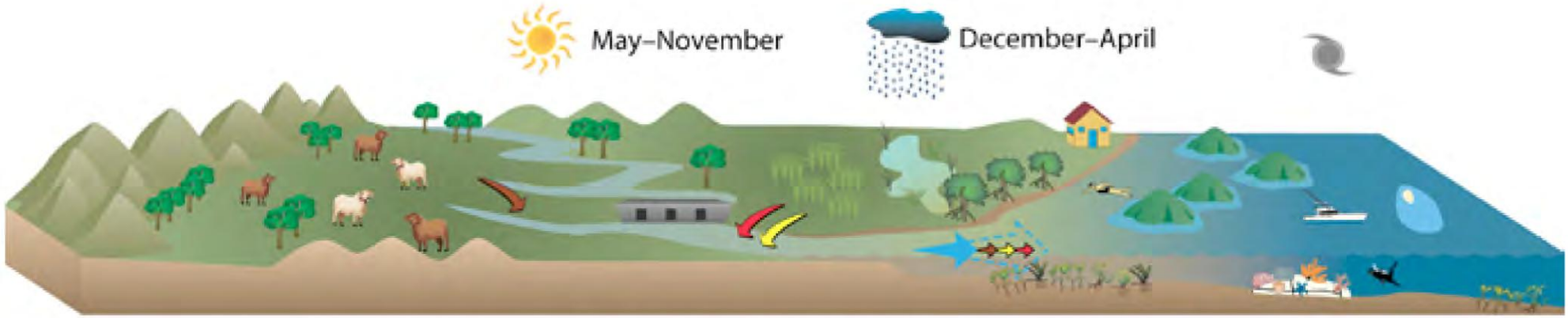
Click like to follow Joel's work at
https://www.facebook.com/pandanusprotection



https://www.facebook.com/pandanusprotection/videos/499532473720640/

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An understanding of diversity loss factors also allows managers of marine parks to conceptualise management of grouped ecosystems, so as to engage stakeholders in effective decision making. For example, the Mackay catchment model.



Mackay region connectivity graphic

https://www.reefplan.qld.gov.au/measuring-success/report-cards/assets/mackay-whitsunday-region.pdf

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Question

Give examples of how each of the following causes loss of diversity in an ecosystem. Consider using a mangrove jack as an example.

Factor	Example of effect on ecosystem diversity loss
Natural hazard	
Loss/fragmentation of habitat	
Pollution	
Over exploitation	
Introduction of new species	
Disease	

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T042 Simpson's diversity index



Bob Moffatt

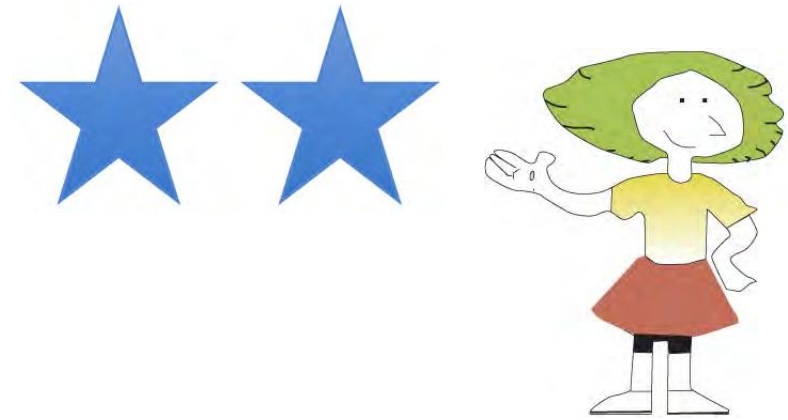
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Syllabus statement

At the end of this topic you should be able to ...

Calculate

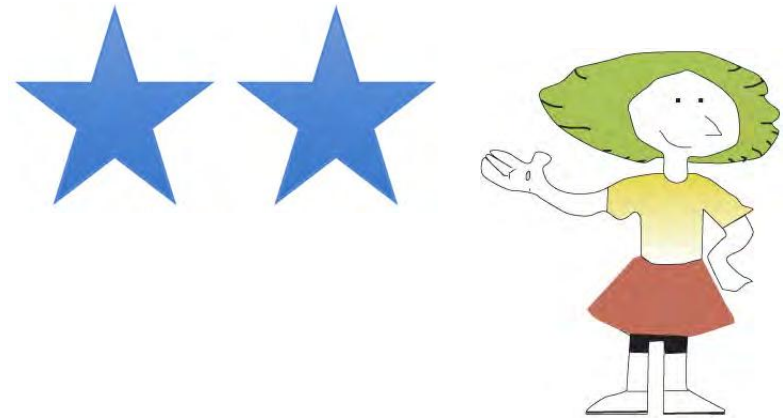
the biodiversity of a marine ecosystem using Simpson's diversity index (SDI).



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Calculate

- determine or find (e.g. a number, answer) by using mathematical processes;
- obtain a numerical answer showing the relevant stages in the working;
- ascertain/determine from given facts, figures or information[formula will be given]



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Objective

Use sand dune plant transect data from the table below, to calculate a Simpson's biodiversity index using the formula.

Species	Number (n)
Spinifex	2
Goats foot	8
Sea oak	1
Pig face	1
Pandanas	3
	N

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The study site is a sand dune on the edge of a marine reserve called Beach B.



Bob Moffatt

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The results of our transect are in the table.



Bob Moffatt

Species	Number (n)
Spinifex	2
Goats foot	8
Sea oak	1
Pig face	1
Pandanas	3
	N

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$$D = 1 - \left(\frac{\sum n(n-1)}{N(N-1)} \right)$$

Where

n = the total number of organisms of a particular species

N = the total number of organisms of all species

$\sum$ = the sum of

D = is Simpsons index

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The steps in the formula are:

1.Count the total number of all species (N) and then set this aside.

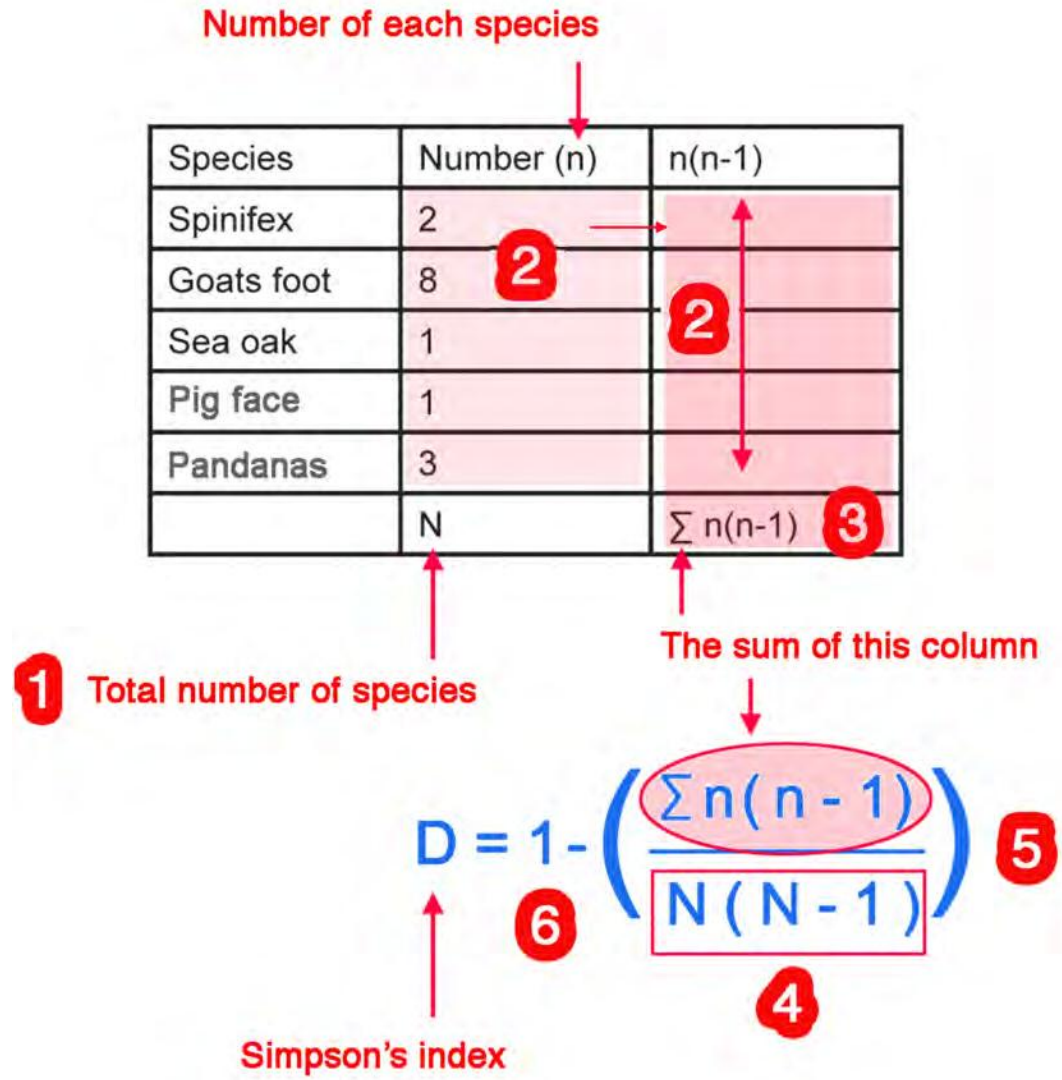
2.Multiply the total number of organisms of each species by that same number minus 1 and place in a column

3.Then add that column

4.Take the total number of all species N and multiply it by that same number minus 1

5.Divide this number into the previous and then

6.Take this number away from 1



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Species	Number (n)	n(n-1)
Spinifex	2	2
Goats foot	8	56
Sea oak	1	0
Pig face	1	0
Pandanas	3	6
	N 15	∑ n(n-1) 64

1 Calculate N: Ans = 15

2 Calculate n(n – 1).

Spinifex	2(2-1) = 2x1	= 2
Goats foot	8(8-1) = 8 x 7	= 56
She oak	1(1-1) = 1 x 0	= 0
Pig face	1(1-1) = 1 x 0	= 0
Pandanas	3(3-1) = 3 x 2	= 6
	Σn(n-1)	Σ = 64

3 Calculate

4 $N(N-1)$

$15 \times 14 = 210$

5 $\left(\frac{\sum n(n-1)}{N(N-1)}\right)$

$= \frac{64}{210} = 0.3$

Simpson's index

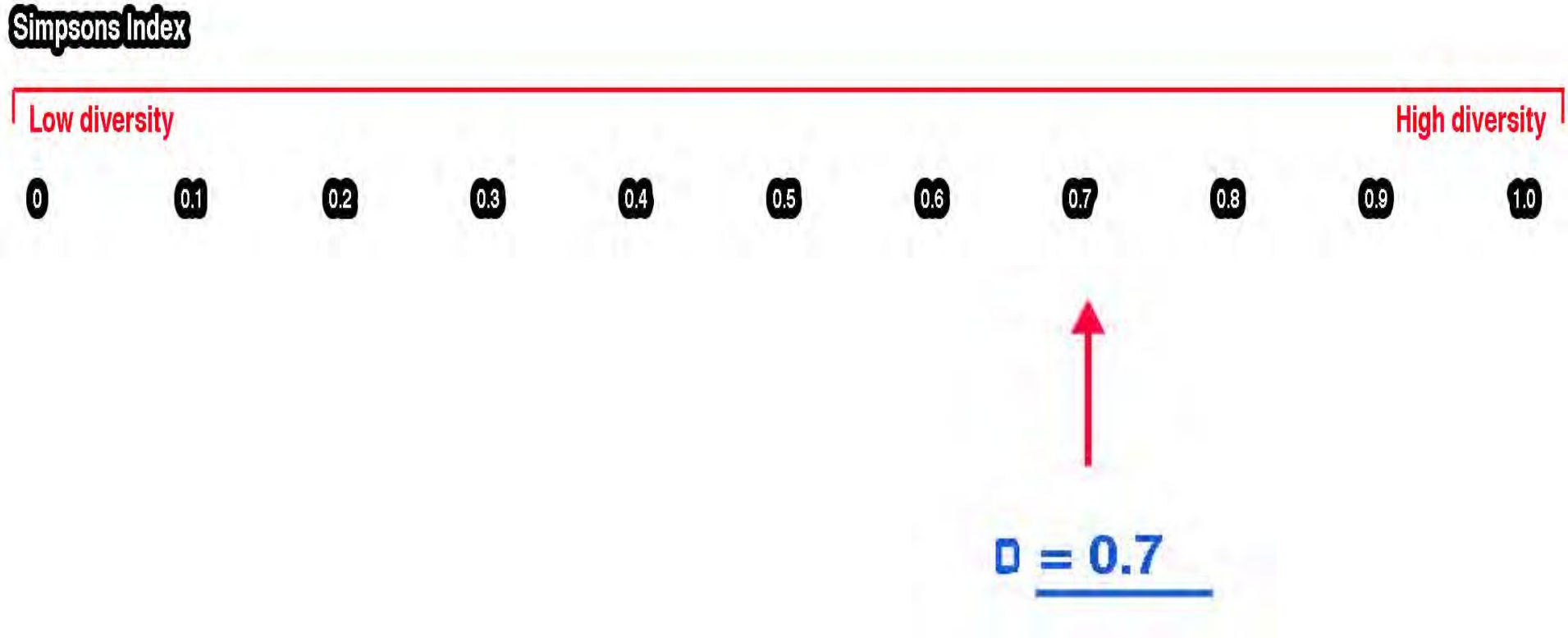
$D = 1 - \left(\frac{\sum n(n-1)}{N(N-1)}\right)$ **6**

$= 1 - 0.3$

$= 0.7$

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Simpsons figures range from 0 - 1, with 1 the highest diversity, so our figure of 0.7, places our community of plants at the upper end of diversity.



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So what does this mean ?

Ecologists, such as those working for the Environmental Agency, are interested in species diversity. This is because diversity is usually proportional to the stability of the ecosystem; the greater the diversity, the greater the stability.

Dune rehabilitation requires massive financial costs and diversity indices often hold the key to funding programs.



Bilinga beach restoration $20 million

Bob Moffatt

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Tweed catchment
http://tweedlandcare.org.au/projects/

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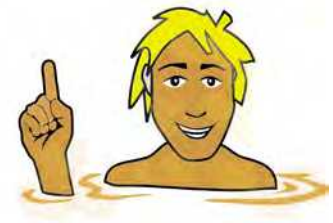
The most stable communities have large numbers of species which are fairly evenly distributed in good-sized populations. Diversity is therefore a factor in successful conservation management.

A diversity index takes into account

the number of species present,

as well as

the abundance of each species.



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Species diversity should not be confused with species richness.

The number of species per sample, e.g. plants in a $1m^2$ quadrat, can be used as a measure of richness, which is subject for the need for us to use other indices.



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Question

Use pen and notebook to calculate SDI from the following data:

Species	Number (n)
Spinifex	2
Goats foot	8
Sea oak	1
Pig face	1
Pandanas	3
	N

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T043 Apply biodiversity data



Bob Moffatt

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Syllabus statement

At the end of this topic you should be able to ...

Apply

data to determine the biodiversity of a marine ecosystem using diversity indices



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Apply

- use knowledge and understanding in response to a given situation or circumstance; carry out or use a procedure in a given or particular situation

[formula will be given]

- You need Microsoft Excel



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Objectives

Q1: Using data and Simpson's index below, determine if plants from one sand dune area on a beach are more diverse than another.

$$D = 1 - \left(\frac{\sum n(n-1)}{N(N-1)} \right)$$

Q2. Using the same data apply Shannon's diversity index (H) to account for abundance and evenness to see if this index creates a different interpretation on diversity.

$$H = -\sum (n/N) \ln(n/N)$$

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Q1. Comparison of two beaches

$$D = 1 - \left(\frac{\sum n(n-1)}{N(N-1)} \right)$$

Where

n = the total number of organisms of a particular species

N = the total number of organisms of all species

$\sum$ = the sum of

D = is Simpsons index

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In this exercise we use beach B with an SDI of 0.7, and compare it to another area close by called beach A on the edge of the reserve with a car park.



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But now lets collect and tabulate data from beach A.

Species	Number (n)
Spinifex	12
Goats foot	2
Sea oak	0
Pig face	0
Pandanas	1
	N=15

Beach A



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So we can now compare it to beach A

Species	Number (n)
Spinifex	12
Goats foot	2
Sea oak	0
Pig face	0
Pandanas	1
	N=15

Beach A



Beach B



Species	Number (n)
Spinifex	2
Goats foot	8
Sea oak	1
Pig face	1
Pandanas	3
	N=15

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We already know Beach B's SDI at .7 and by applying Simpsons index to Beach a we get an SDI of 0.4.

Beach A

Species	Number (n)
Spinifex	12
Goats foot	2
Sea oak	0
Pig face	0
Pandanas	1
	N=15



Beach B



Species	Number (n)
Spinifex	2
Goats foot	8
Sea oak	1
Pig face	1
Pandanas	3
	N=15

$$D = 1 - \left(\frac{\sum n(n-1)}{N(N-1)} \right)$$

Beach A

Species	Number (n)	n(n-1)
Spinifex	12	132
Goats foot	2	2
Sea oak	0	0
Pig face	0	0
Pandanas	1	0
	N=15	∑ n(n-1) 134

$$D = 1 - \left(\frac{\sum n(n-1)}{N(N-1)} \right)$$

$$= 1 - \left(\frac{134}{210} \right)$$

$$= 1 - 0.6$$

$$= 0.4$$

Beach B

Species	Number (n)	n(n-1)
Spinifex	2	2
Goats foot	8	56
Sea oak	1	0
Pig face	1	0
Pandanas	3	6
	N=15	∑ n(n-1) 64

$$D = 1 - \left(\frac{\sum n(n-1)}{N(N-1)} \right)$$

$$= 1 - \left(\frac{64}{210} \right)$$

$$= 1 - 0.3$$

$$= 0.7$$

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So Beach A has an SDI = 0.4 compared to Beach B SDI = 0.7 and might be due to the fact that Beach A is beside a beach walkway.



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Rezoning application, marine reserve edge.

Environmental Scientists from the local city council will want to know how abundant and how even the distribution of plants are so they can consider an application for a rezoning at the edge of the marine reserve



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So this is where the Shannon diversity index (H) is used to account for both abundance and evenness of the species present.

Variables in the formula :

H	Shannon's diversity index
N	total number of species in the community (richness)
n/N	proportion of N made up of the number of n species
ln	is the natural log of the product of n/N

$$H = -\sum(n/N)\ \ln(n/N)$$

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Species evenness refers to how close in numbers each species in an environment is.





So if there are 4 Goat's feet, and 100 Spinifex plants per 10 square metres, the community is not very even.

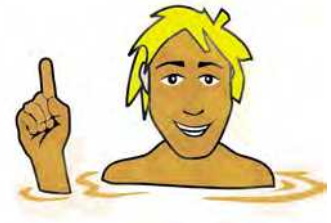
But if there are 4 Goat's feet and 6 Spinifex plants per 10 square metres, the community is quite even.

The higher the number the higher the evenness.

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This index provides information about

Rarity and commonness



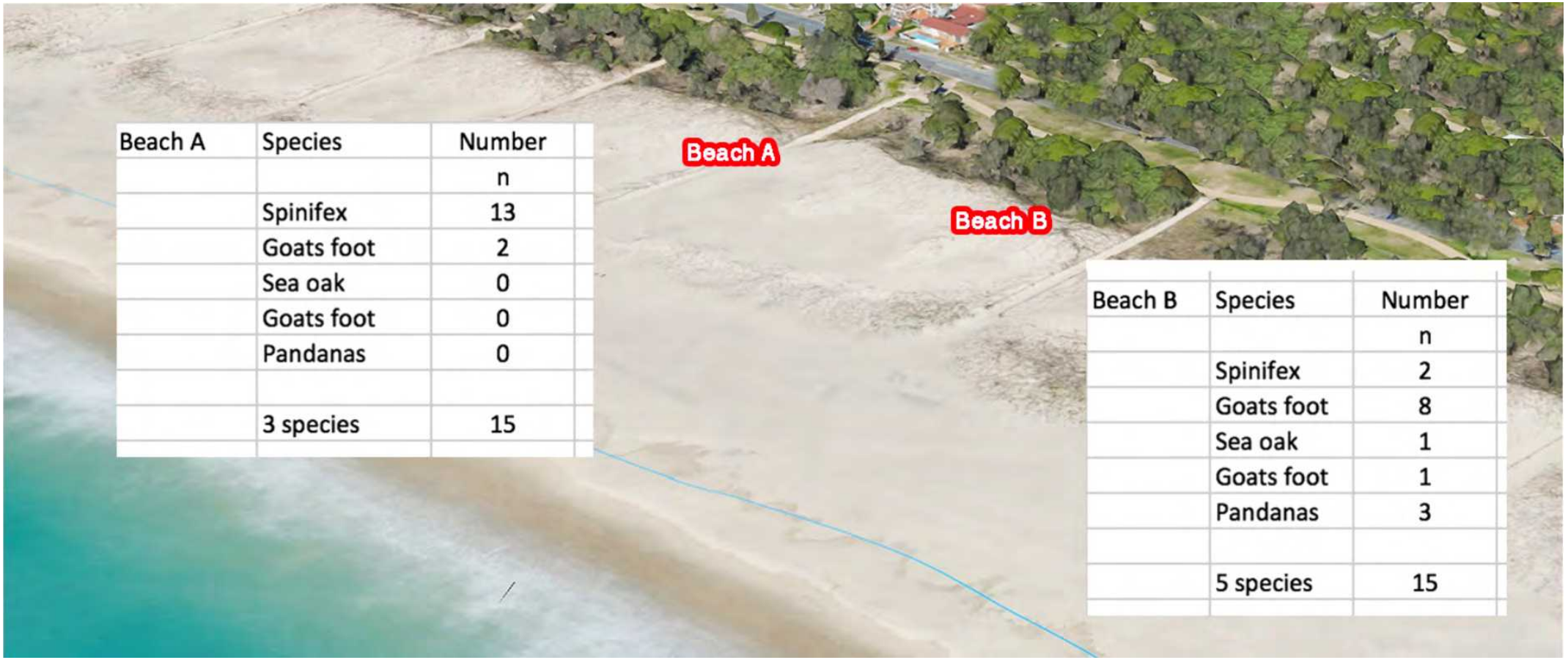
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Video

https://www.youtube.com/watch?v=0fsZr5U07aw



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Beach A	Species	Number
		n
	Spinifex	13
	Goats foot	2
	Sea oak	0
	Goats foot	0
	Pandanas	0
	3 species	15

Beach B	Species	Number
		n
	Spinifex	2
	Goats foot	8
	Sea oak	1
	Goats foot	1
	Pandanas	3
	5 species	15

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Beach	Species	Number	Proportion	Natural log of n/N	Product of proportion * natural log
B	name	n	n/N	ln(n/N)	n/N x ln(n/N)
	Spinifex	2			
	Goats foot	8			
	Sea oak	1			
	Goats foot	1			
	Pandanas	3			
5 species	Total (N)	15			

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Step 1

	A	B	C
1	**Shannon-Weiner Dive**		
2			
3			
4			
5	Example		Number
6	Beach B	Species	n
7		Spinifex	2
8		Goats foot	8
9		Sea oak	1
10		Goats foot	1
11		Pandanas	3
12			
13	5 species	Total (N)	=SUM(C7:C11)
14			
15	Shannon index H	equals - Sum(n/N x ln(n/N)	
16			

Step 1

	A	B	C	D
1	**Shannon-Weiner Diversity Index**			
2				
3				
4				
5	Example		Number	
6	Beach B	Species	n	
7		Spinifex	2	
8		Goats foot	8	
9		Sea oak	1	
10		Goats foot	1	
11		Pandanas	3	
12				
13	5 species	Total (N)	15	
14				

Step 1

N = 15

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Step 2

	A	B	C	D
1	**Shannon-Weiner Dive**			
2				Step 2
3				
4				
5	Example		Number	Proportion
6	Beach B	Species	n	n/N
7		Spinifex	2	=(C7/C13)
8		Goats foot	8	=(C8/C13)
9		Sea oak	1	=(C9/C13)
10		Goats foot	1	=(C10/C13)
11		Pandanas	3	=(C11/C13)
12				
13	5 species	Total (N)	=SUM(C7:C11)	
14				

	A	B	C	D
1	**Shannon-Weiner Diversity Index**			
2				Step 2
3				
4				
5	Example		Number	Proportion
6	Beach B	Species	n	n/N
7		Spinifex	2	0.13
8		Goats foot	8	0.53
9		Sea oak	1	0.07
10		Goats foot	1	0.07
11		Pandanas	3	0.20
12				
13	5 species	Total (N)	15	
14				

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Step 3

			C	D	E
1	Shannon-Weiner Diversity Index				
2					
3					
4					Natural
5	Example		Number	Proportion	log of n/N
6	Beach B	Species	n	n/N	ln(n/N)
7		Spinifex	2	=(C7/C13)	=LN(D7)
8		Goats foot	8	=(C8/C13)	=LN(D8)
9		Sea oak	1	=(C9/C13)	=LN(D9)
10		Goats foot	1	=(C10/C13)	=LN(D10)
11		Pandanas	3	=(C11/C13)	=LN(D11)
12					
13	5 species	Total (N)	=SUM(C7:C11)		

Step 3

	A	B	C	D	E
1	Shannon-Weiner Diversity Index				
2					
3					
4					Natural
5	Example		Number	Proportion	log of n/N
6	Beach B	Species	n	n/N	ln(n/N)
7		Spinifex	2	0.13	-2.01
8		Goats foot	8	0.53	-0.63
9		Sea oak	1	0.07	-2.71
10		Goats foot	1	0.07	-2.71
11		Pandanas	3	0.20	-1.61
12					
13	5 species	Total (N)	15		

Step 3

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Step 4

			C	D	E	F
1	Shannon-Weiner Diversity Index					
2						Step 4
3						
4					Natural	Product of
5	Example		Number	Proportion	log of n/N	proportion * natural log
6	Beach B	Species	n	n/N	ln(n/N)	n/N x ln(n/N)
7		Spinifex	2	=(C7/C13)	=LN(D7)	=SUM(D7*E7)
8		Goats foot	8	=(C8/C13)	=LN(D8)	=SUM(D8*E8)
9		Sea oak	1	=(C9/C13)	=LN(D9)	=SUM(D9*E9)
10		Goats foot	1	=(C10/C13)	=LN(D10)	=SUM(D10*E10)
11		Pandanas	3	=(C11/C13)	=LN(D11)	=SUM(D11*E11)

	A	B	C	D	E	F
1	Shannon-Weiner Diversity Index					
2						Step 4
3						
4					Natural	Product of
5	Example		Number	Proportion	log of n/N	proportion * na
6	Beach B	Species	n	n/N	ln(n/N)	n/N x ln(n/N)
7		Spinifex	2	0.13	-2.01	-0.27
8		Goats foot	8	0.53	-0.63	-0.34
9		Sea oak	1	0.07	-2.71	-0.18
10		Goats foot	1	0.07	-2.71	-0.18
11		Pandanas	3	0.20	-1.61	-0.32

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Step 5

	A	B	C	D	E	F
1	**Shannon-Weiner Dive**					
2						
3						
4					Natural	Product of
5	Example		Number	Proportion	log of n/N	proportion * natural log
6	Beach B	Species	n	n/N	ln(n/N)	n/N x ln(n/N)
7		Spinifex	2	=(C7/C13)	=LN(D7)	=SUM(D7*E7)
8		Goats foot	8	=(C8/C13)	=LN(D8)	=SUM(D8*E8)
9		Sea oak	1	=(C9/C13)	=LN(D9)	=SUM(D9*E9)
10		Goats foot	1	=(C10/C13)	=LN(D10)	=SUM(D10*E10)
11		Pandanas	3	=(C11/C13)	=LN(D11)	=SUM(D11*E11)
12						
13	5 species	Total (N)	=SUM(C7:C11)			
14						
15	Shannon index H	equals - Sum(n/N x ln(n/N)			Step 5	=-SUM(F7:F11)
16						

$$H = -\sum(n/N)\ \ln(n/N)$$

	A	B	C	D	E	F
1	**Shannon-Weiner Diversity Index**					
2						
3						
4					Natural	Product of
5	Example		Number	Proportion	log of n/N	proportion * natural log
6	Beach B	Species	n	n/N	ln(n/N)	n/N x ln(n/N)
7		Spinifex	2	0.13	-2.01	-0.27
8		Goats foot	8	0.53	-0.63	-0.34
9		Sea oak	1	0.07	-2.71	-0.18
10		Goats foot	1	0.07	-2.71	-0.18
11		Pandanas	3	0.20	-1.61	-0.32
12						
13	5 species	Total (N)	15			
14						
15	Shannon ir	equals - Sum(n/N x ln(n/N)			Step 5	1.29

$= H$

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So what about Beach A

	A	B	C	D	E	F
1	**Shannon-Weiner Dive**					
2						
3						
33	Example			Proportion	log of Pi	proportion * natural log
34	Beach A	Species	Number	Pi	lnPi	Pi*lnPi
35		Spinifex	13	=(C35/C41)	=LN(D35)	=SUM(D35*E35)
36		Goats foot	2	=(C36/C41)	=LN(D36)	=SUM(D36*E36)
37		Sea oak	0	=(C37/C41)	0	=SUM(D37*E37)
38		Goats foot	0	=(C38/C41)	0	=SUM(D38*E38)
39		Pandanas	0	=(C39/C41)	0	=SUM(D39*E39)
40						
41		3 species	=SUM(C35:C39)			
42						
43	Shannon index H	equals - Sum of Pi*lnPi		=-SUM(F35:F39)		

	A	B	C	D	E	F
33	Example			Proportion	log of Pi	proportion * natural log
34	Beach A	Species	Number	Pi	lnPi	Pi*lnPi
35		Spinifex	13	0.87	-0.14	-0.12
36		Goats foot	2	0.13	-2.01	-0.27
37		Sea oak	0	0.00	0.00	0.00
38		Goats foot	0	0.00	0.00	0.00
39		Pandanas	0	0.00	0.00	0.00
40						
41		3 species	15			
42						
43	Shannon ir	equals - Sum of Pi*lnPi		0.39		
44						

$-\sum(n/N)\ \ln(n/N)$

= H

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Interpretation

Simpsons Index

Low diversity — High diversity

0 — 0.1 — 0.2 — 0.3 — 0.4 — 0.5 — 0.6 — 0.7 — 0.8 — 0.9 — 1.0

Beach A SDI = 0.4

Beach B SDI = 0.7

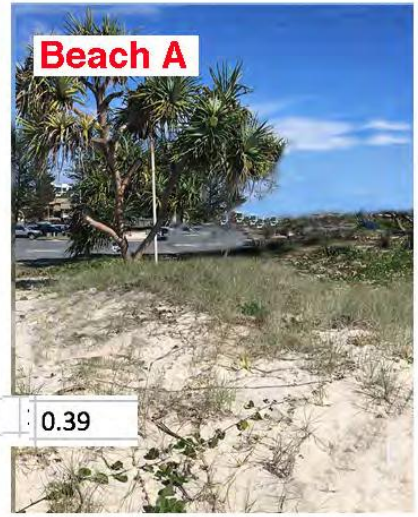
Low — High

0 — 1 — 2 — 3 — 4 — 5

0.39 (Beach A)

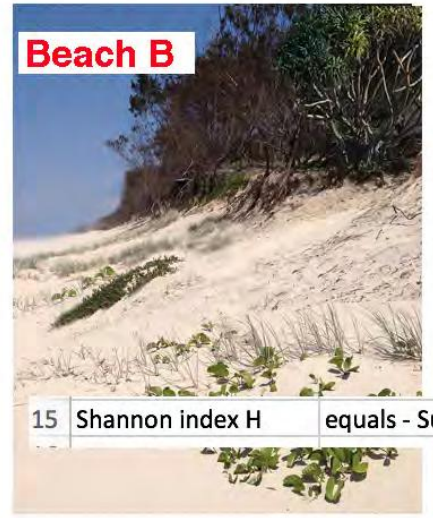
1.29 (Beach B)

Species	Number (n)
Spinifex	12
Goats foot	2
Sea oak	0
Pig face	0
Pandanas	1
	N=15



Shannon index H

equals - Sum(n/N x ln(n/N)) 0.39



Species	Number (n)
Spinifex	2
Goats foot	8
Sea oak	1
Pig face	1
Pandanas	3
	N=15

15 Shannon index H equals - Sum(n/N x ln(n/N)) 1.29

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Recommendation to council

So if Shannon's index is a measure of abundance and evenness of the species present, we can say that the abundance and evenness of dune plants is low and needs to be PROTECTED.



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Application of data



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So can you now

Apply data to determine the biodiversity of a marine ecosystem using diversity indices.



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Ok calculate and SDI and Shannon's index for the following data and use your knowledge to say if the beaches have a diverse sand dune cover of plants

Beach A

Species	Number (n)
Spinifex	12
Goats foot	2
Sea oak	0
Pig face	0
Pandanas	1
	N=15



Beach B



Species	Number (n)
Spinifex	2
Goats foot	8
Sea oak	1
Pig face	1
Pandanas	3
	N=15

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T044 Important ecosystem definitions

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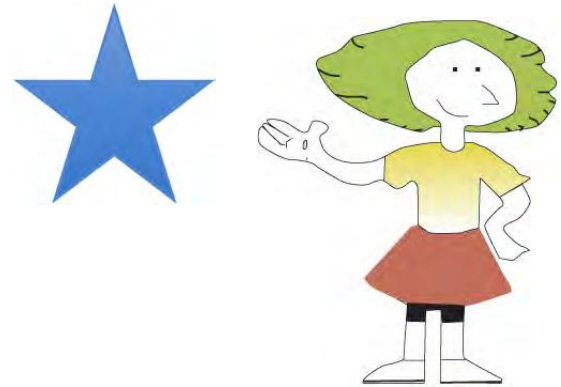
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Syllabus statement

At the end of this topic you should be able to ...

Define

ecosystem resilience, disturbance and recovery.

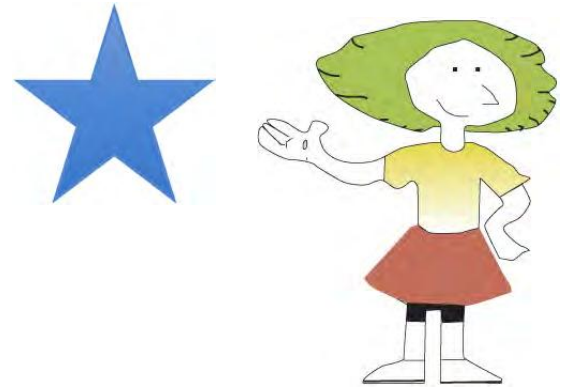


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Define

give the meaning of a word, phrase, concept or physical quantity;

state meaning and identify or describe qualities.



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Objective

Define:

•Ecosystem resilience

•Ecosystem disturbance

•Ecosystem recovery

and give an example of each.



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Ecosystem resilience

The capacity of an ecosystem to recover from a disturbance or withstand ongoing pressures.



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For example

Resilience is the ability of a sand dune to recover from storms, reefs to recover from climate change or fish stocks to recover from overfishing.



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Ecosystem disturbance

•a temporary change in environmental conditions that alters physical structures or arrangements of biotic and abiotic elements within an ecosystem;

•can also occur over larger temporal (timespan) scales and affects diversity;

•can be natural or anthropogenic.



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For example major ecological disturbances may include:

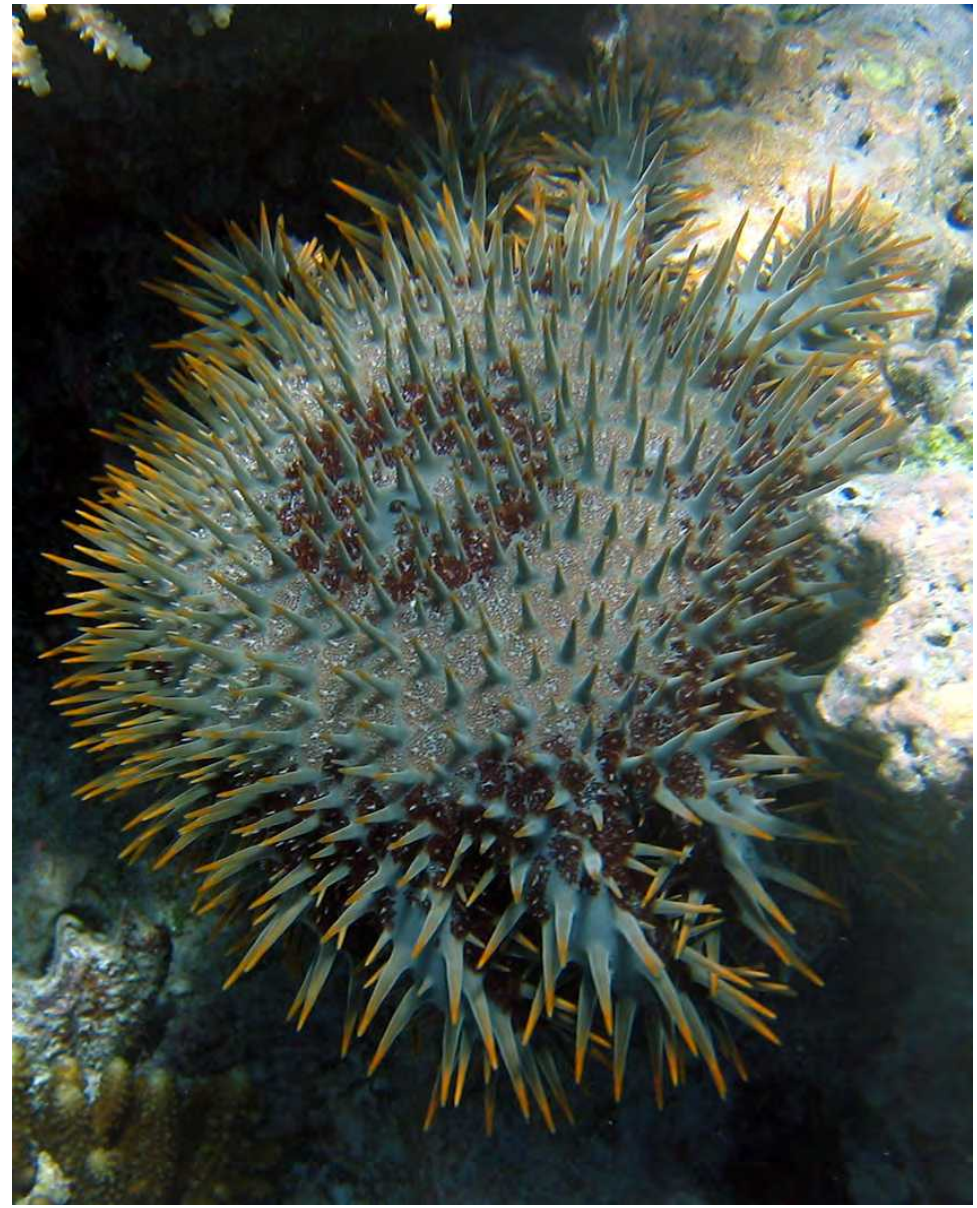
Flooding



Sediment run off from land Hervey Bay
Bob Moffatt

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Pest outbreaks



Crown of thorns starfish

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Anthropogenic

The devastating effects of human impact on the environment (anthropogenic disturbances) such as over fishing, coastal development and the introduction of invasive species.



Fisherman sort trawler catch

Qld fisheries

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Coral trampling, earthquakes, various types of volcanic eruptions and tsunami.



Coral trampling by groups on reef

Bob Moffatt

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Ecosystem recovery

The return of a damaged ecological system and associated ecosystem services to a stable state.

For example the rehabilitation of a portion of Johnson Creek in south eastern Australia, to restore bioswale and flood control functions of the land which had long been converted to pasture for cow grazing.



By Nick carson at English Wikipedia (Transferred from en.wikipedia to Commons.) [Public domain], via Wikimedia Commonshttps://upload.wikimedia.org/wikipedia/commons/8/86/Wetland_restoration_in_Australia.jpg

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Estuarine rubble drain and riparian vegetation restoration

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Questions

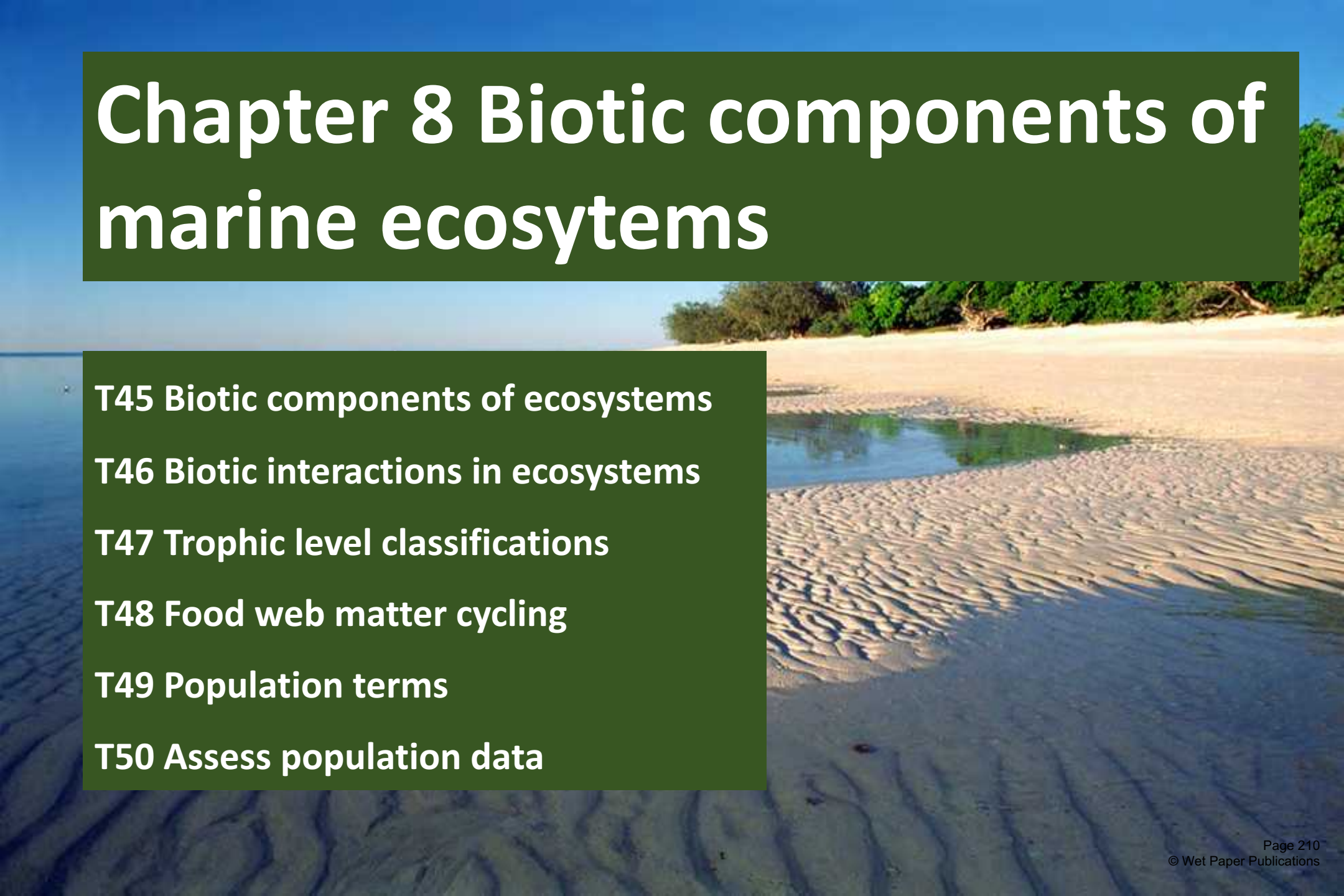
- Complete the table below to define the ecosystem terms resilience, disturbance and recovery.
- Give an example of each.

Term	Definition	Example
Ecosystem resilience		
Ecosystem disturbance		
Ecosystem recovery		

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Chapter 8 Biotic components of marine ecosytems



T45 Biotic components of ecosystems

T46 Biotic interactions in ecosystems

T47 Trophic level classifications

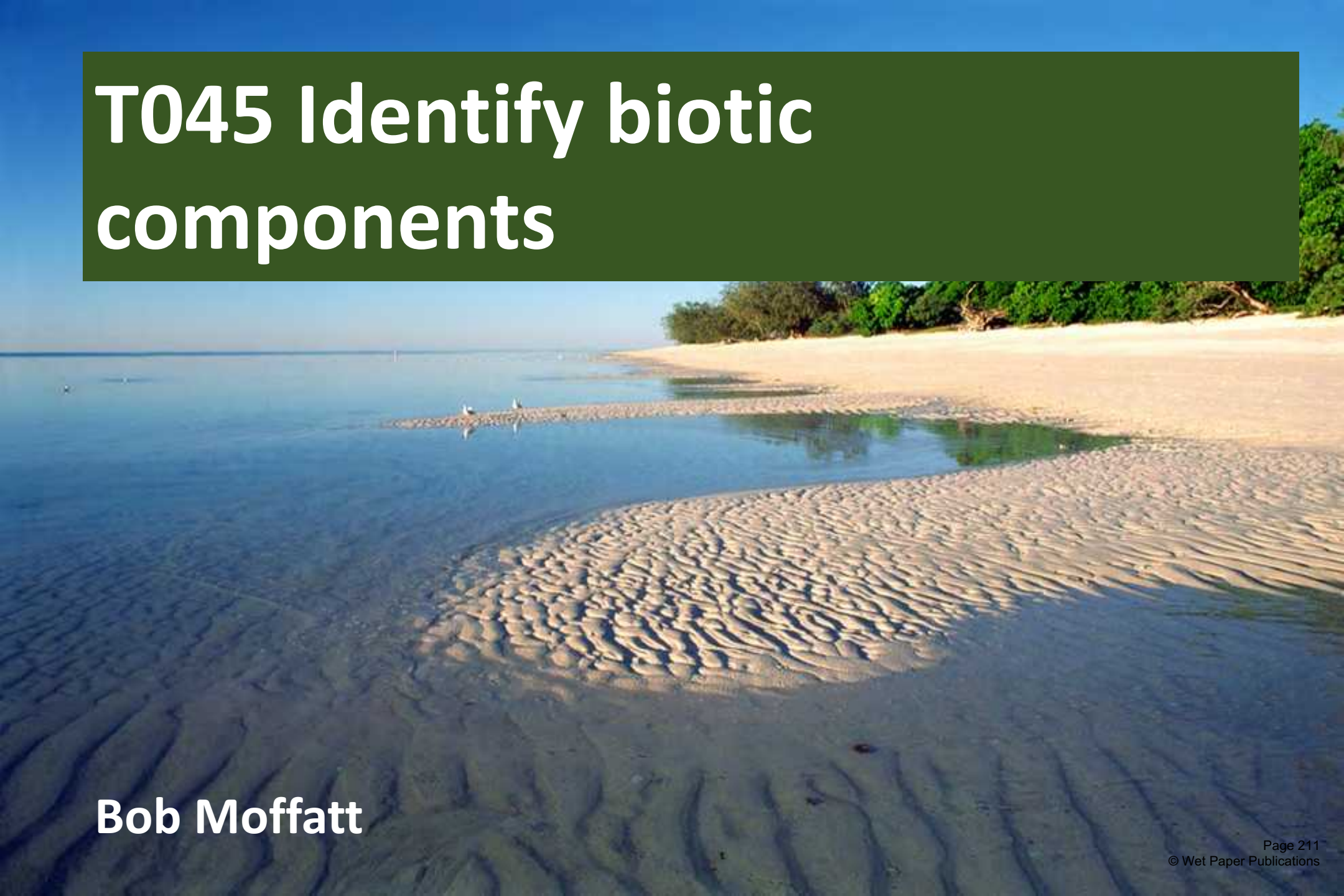
T48 Food web matter cycling

T49 Population terms

T50 Assess population data

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T045 Identify biotic components



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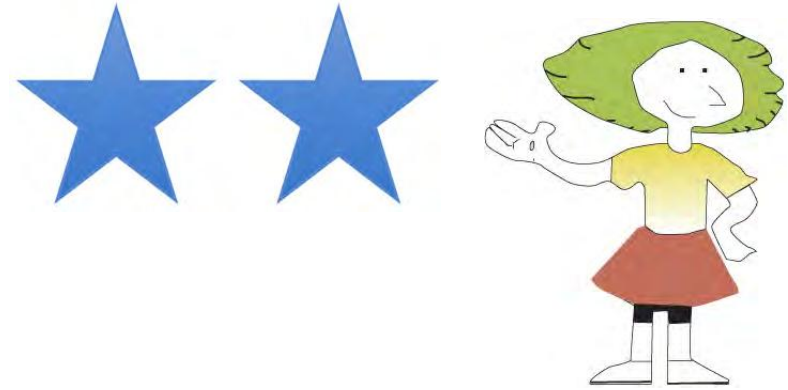
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Syllabus statement

At the end of this topic you should be able to ...

Identify

biotic components of marine ecosystems (i.e. trophic levels, food chains, food webs, interactions and population dynamics)



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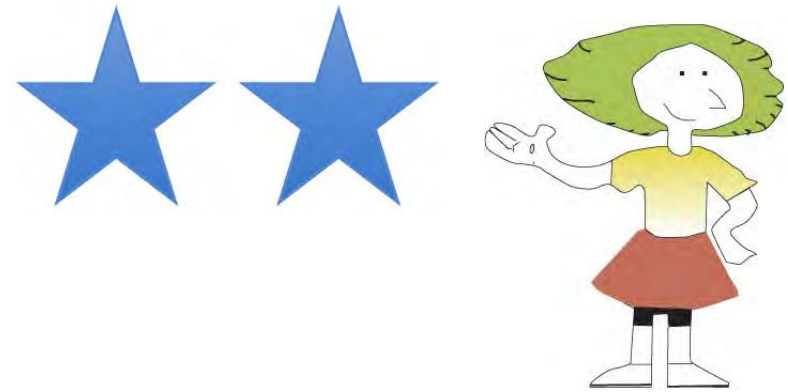
Identify

Locate, recognise and name;

Establish or indicate who or what someone or something is;

pProvide an answer from a number of possibilities;

Recognise and state a distinguishing factor or feature



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Objective

Locate biotic components of marine ecosystems using a table of information

(i.e. trophic levels, food chains, food webs, interactions and population dynamics)

References used

https://en.wikipedia.org/wiki/Food_chain

https://en.wikipedia.org/wiki/Trophic_level

https://en.wikipedia.org/wiki/Food_web



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Definition

Biotic components or biotic factors, can be described as any living component that affects another organism, or shapes the ecosystem.

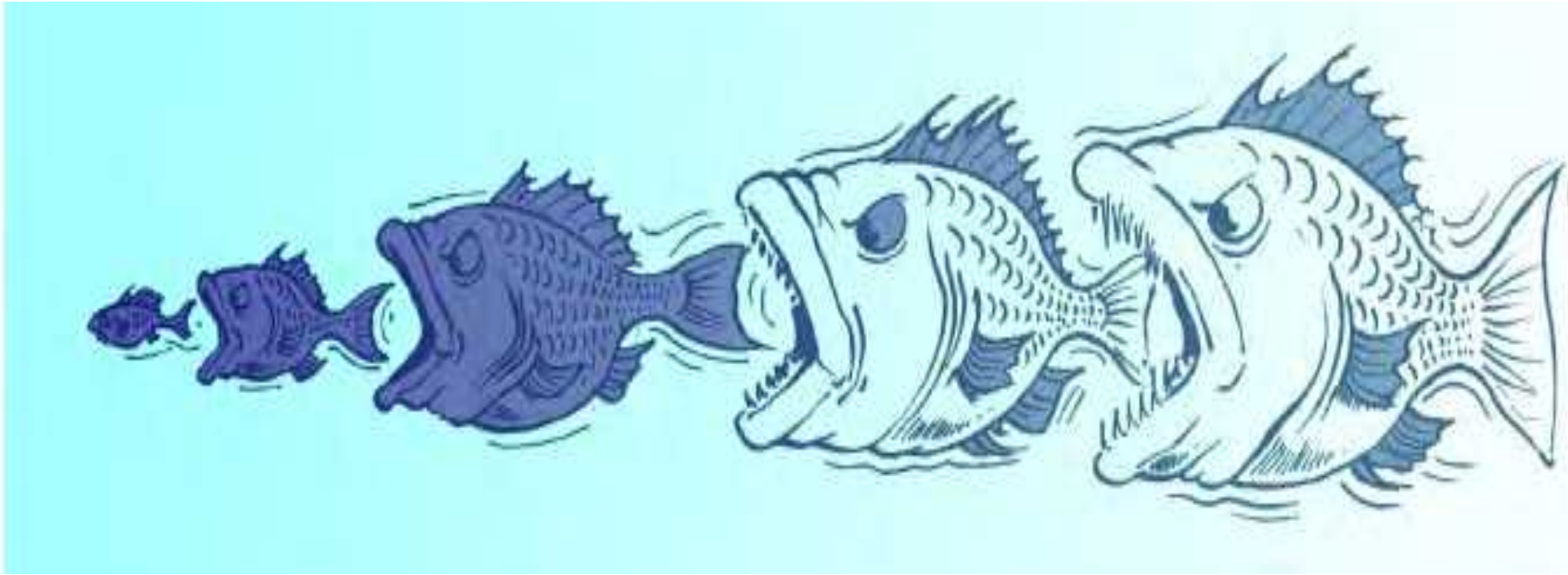
- This includes both animals that consume other organisms within their ecosystem, and the organism that is being consumed.
- Biotic factors also include human influence, pathogens, and disease outbreaks.
- Each biotic factor needs the proper amount of energy and nutrition to function day to day.



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Food chains – ways to identify

A food chain is a succession of organisms that eat other organisms and may, in turn, be eaten themselves.



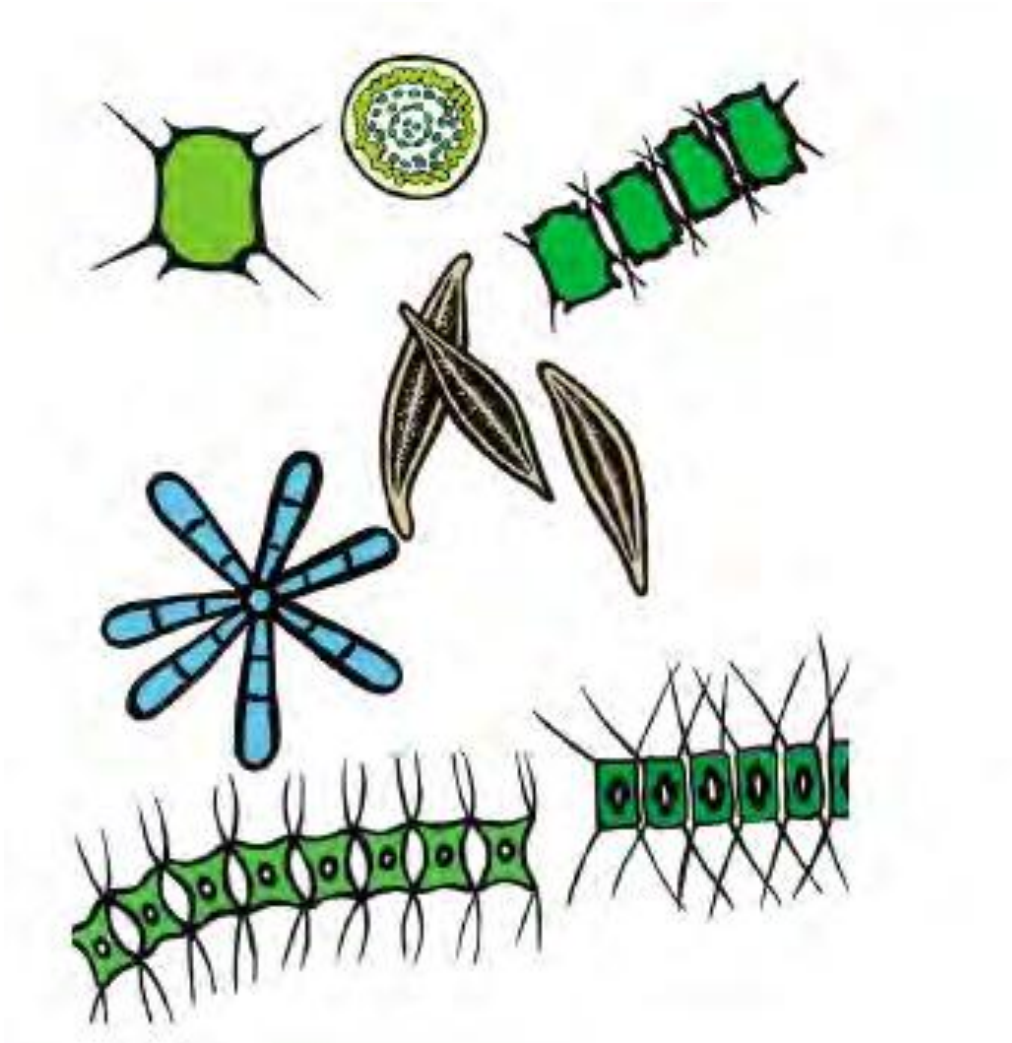
Sharyn Madder

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Food chains – the basic interactions

The three basic ways in which an organism can get their food are as producers, consumers or decomposers.

Eg., Plankton are producers.



Sharyn Madder

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Producers (autotrophs) are typically plants or algae

Plants and algae do not usually eat other organisms, but pull nutrients from the soil or the ocean and manufacture their own food using photosynthesis.

For this reason, they are called primary producers. In this way, it is energy from the sun that usually powers the base of the food chain.



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An exception occurs in deep-sea hydrothermal ecosystems, where there is no sunlight. Here primary producers manufacture food through a process called chemosynthesis.

The ecosystem so formed is reliant upon the continued existence of the hydrothermal vent field as the primary source of energy, which differs from most surface life on Earth, which is based on solar energy.



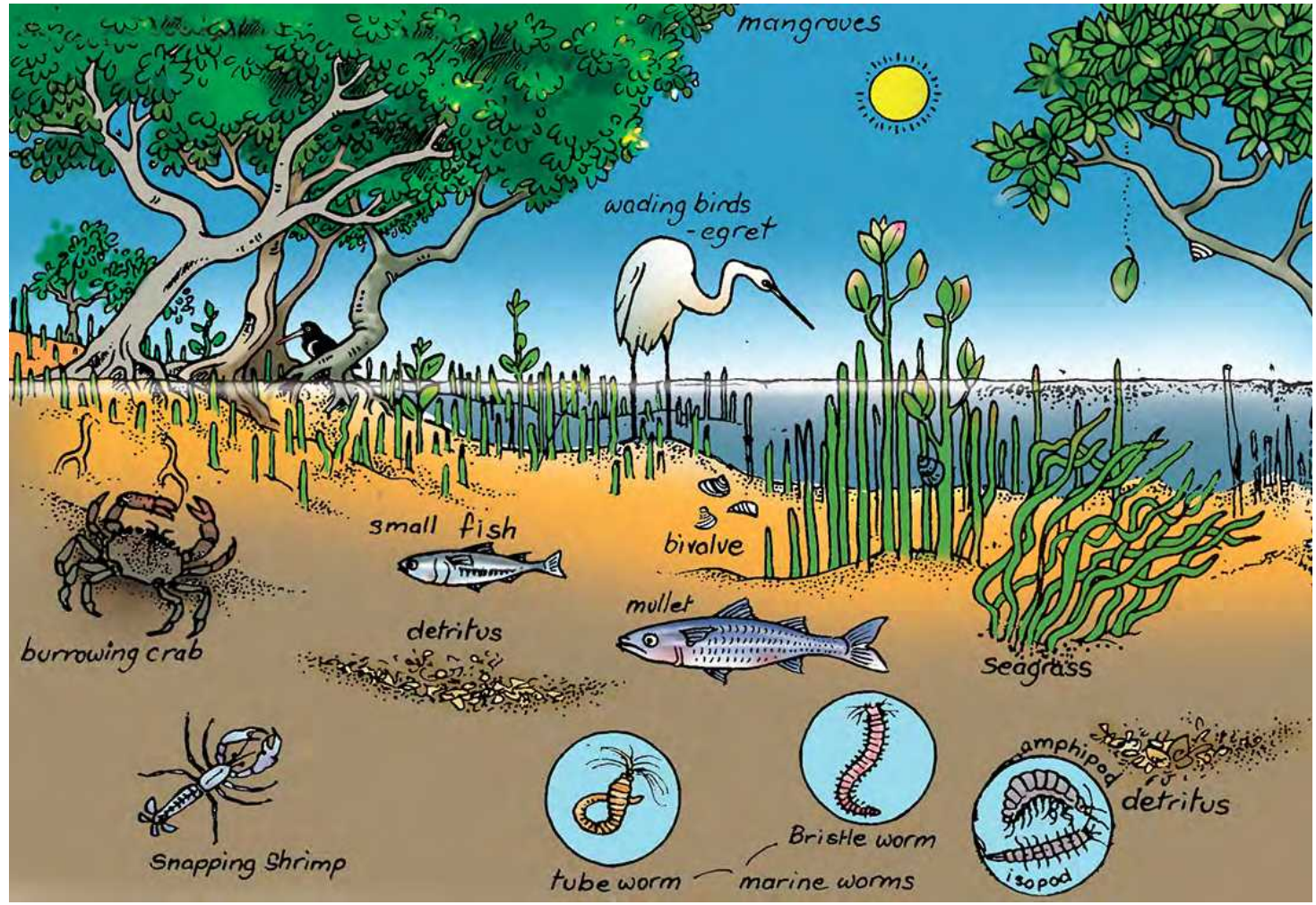
By NOAA Okeanos Explorer Program, Galapagos Rift Expedition 2011 - Flickr NOAA Photo Library, Public Domain, https://commons.wikimedia.org/w/index.php?curid=35246911

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Consumers (heterotrophs) are species that cannot manufacture their own food and need to consume other organisms.

Animals that eat primary producers (like plants) are called herbivores.

Animals that eat other animals are called carnivores, and animals that eat both plant and other animals are called omnivores.



Nancy Tsernjavski and Sharyn Madder and Kerry Kitzelman

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Decomposers (detritivores) break down dead plant and animal matter and wastes and release it again as energy and nutrients into the ecosystem for recycling.

Decomposers, such as bacteria and fungi (mushrooms), feed on waste and dead matter, converting it into inorganic chemicals that can be recycled as mineral nutrients for plants to use again.

They are crucial in the cycling of nutrients in ecosystems.



Mangrove and fungi
Bob Moffatt

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Food chains - the population dynamics

Species interactions

Nearly all species are influenced by biotic factors in one way or another.

If the number of predators was to increase, the entire food chain would be affected, as any prey falling below that specified predator in the food chain, will decrease in population with the added pressure of more predators.

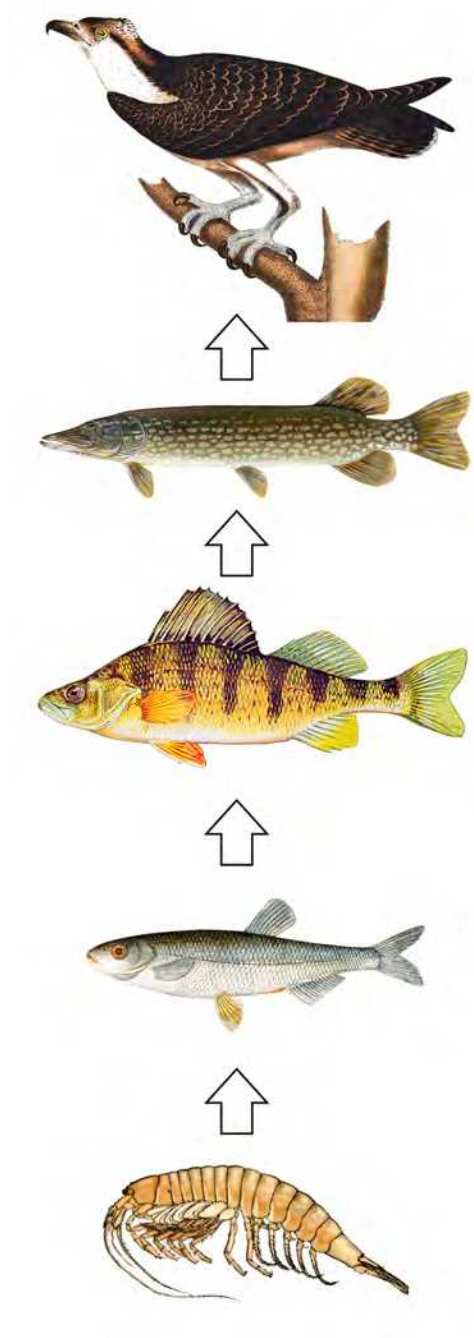


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If the prey is not given enough time by the predator to repopulate, this could not only cause endangerment and extinction in the prey, but the predator as well.

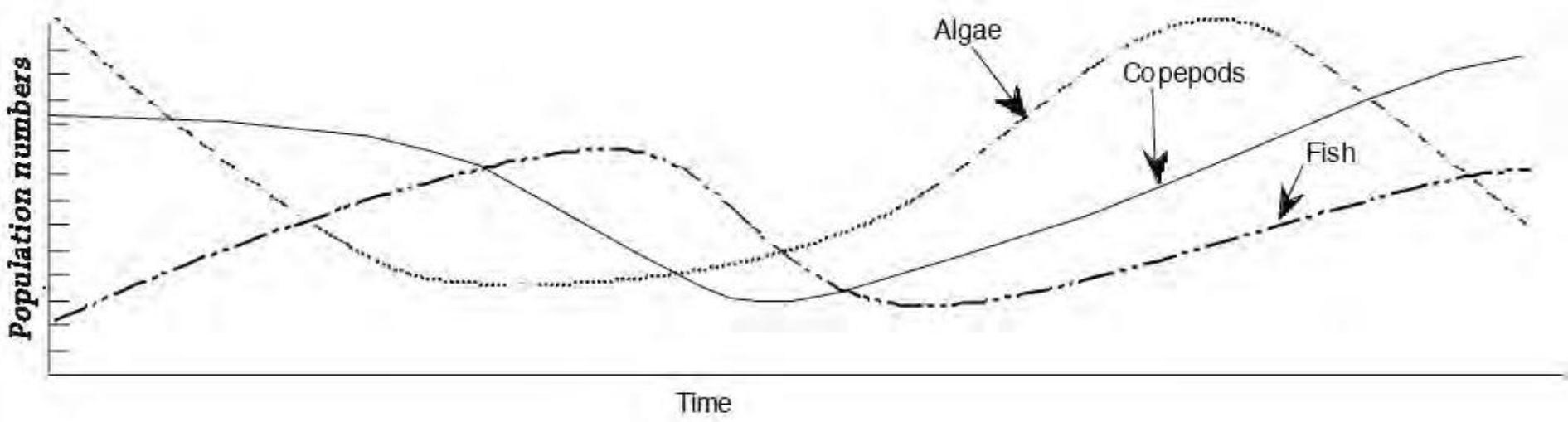
Eg., All the fish will be eaten and then the osprey will die from starvation.



By Composition by Amada44 - File:The_birds_of_North_America_(PL._XVI)_(6022686172).jpgFile:Esox_lucius1.jpgFile:Yellow_perch_fish_perca_flavescens.jpgFile:Ichthyologie;_ou,_Histoire_naturelle_des_poissons_(Plate_8)_(7064394907).jpgFile:FMIB_46282_Tasmanian_'Mountain_Shrimp'_(Anaspides_tasmaniae),_a_living_representative_of_the_Syncarida.jpeg, Public Domain, https://commons.wikimedia.org/w/index.php?curid=53128434

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Contradicting a decrease in population size, if a particular species reproduces too rapidly, this will cause an increase in population size, thus affecting other populations around them.



Tim Ryan

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Pathogens and disease outbreaks

When disease outbreaks occur, it can be detrimental to an ecosystem.

When a disease hits, it will usually affect more than one species, thus causing a serious outbreak.

This has the potential to set off a chain reaction thus, causing endangerment to a variety of species within that ecosystem.



Prawn white spot disease

Qld Fisheries Service

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Human contact

Humans make the most sudden and long-term changes in an environment (e.g. pollution and waste).

These changes either drive species out of their territory or force them to adapt to their new surroundings.

These changes have the largest impact on an ecosystem's population sizes, typically causing serious decreases.



Fishers on a reef

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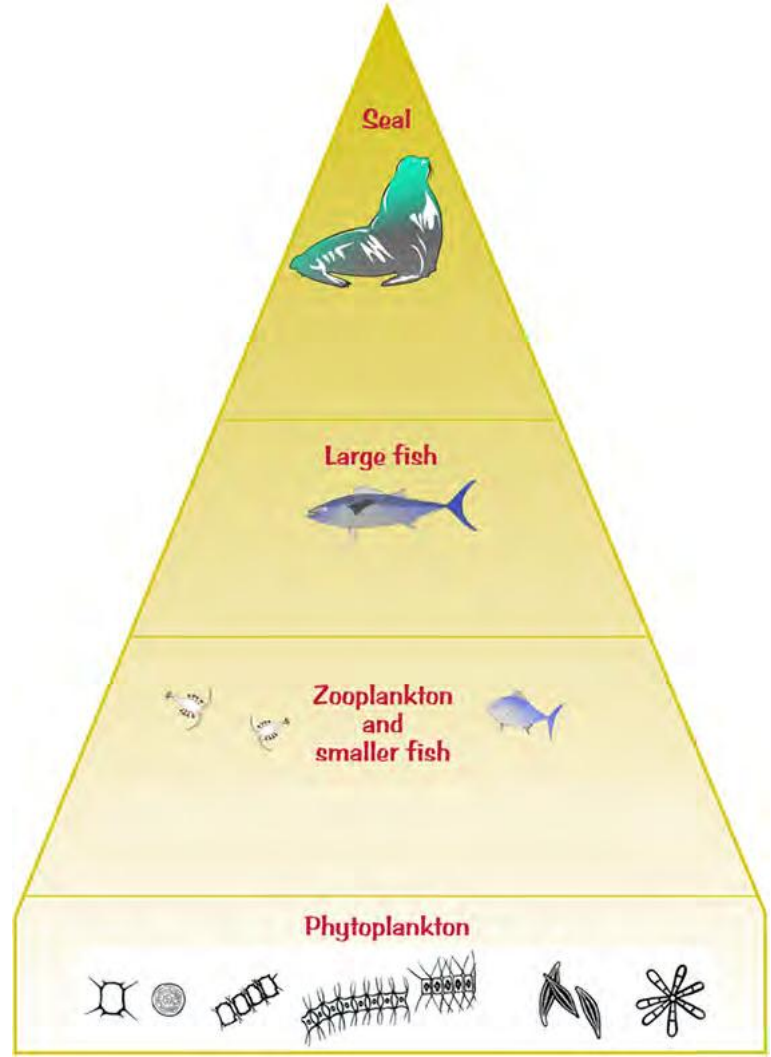
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Trophic levels - how to identify one

The trophic level of an organism is the position it occupies in a food chain.

Trophic levels can be represented by numbers, starting at level 1 with plants.

Further trophic levels are numbered subsequently according to how far the organism is along the food chain.



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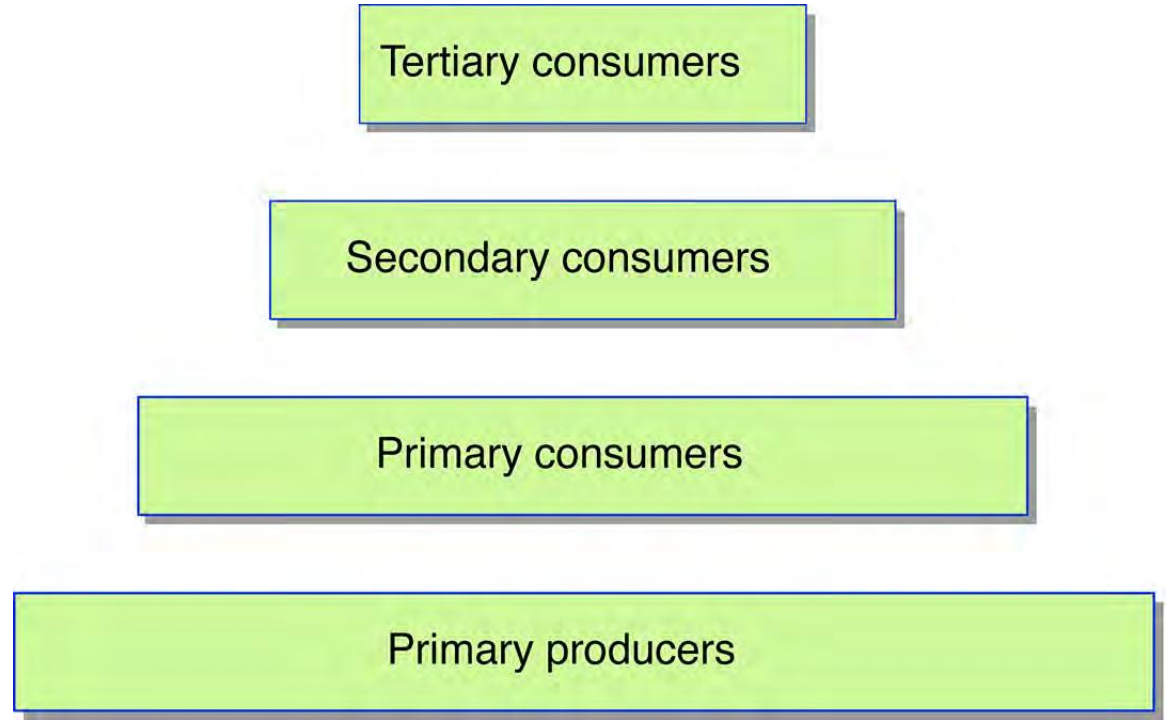
Trophic levels - interactions

Level 1: Plants and algae make their own food and are called producers.

Level 2: Herbivores eat plants and are called primary consumers.

Level 3: Carnivores that eat herbivores are called secondary consumers.

Level 4: Carnivores that eat other carnivores are called tertiary consumers.



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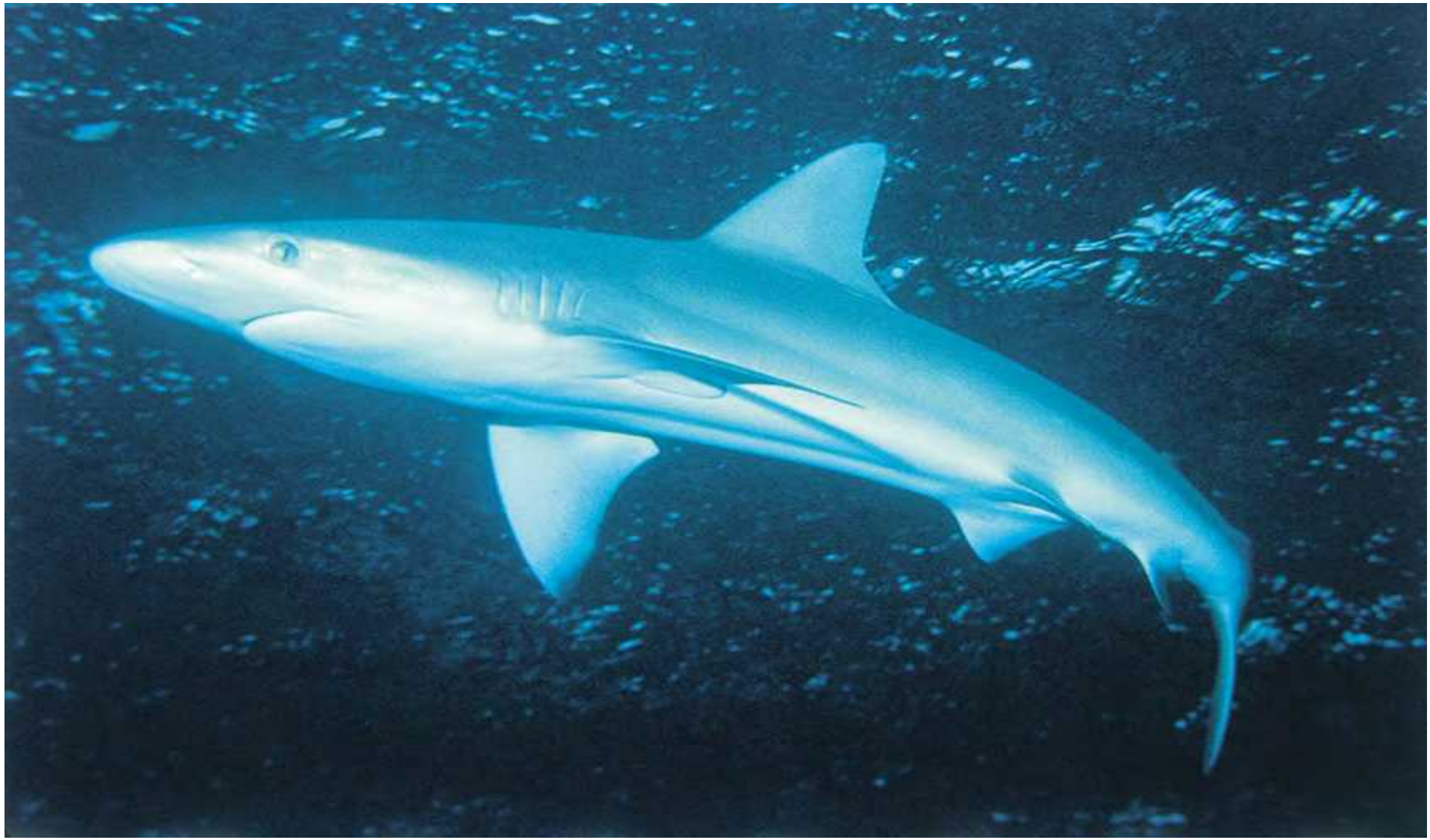
Level 5: Apex predators that have no predators are at the top of the food chain.

Killer whales (orca) are apex predators but they are divided into separate populations, hunting specific preys varying from tuna, small sharks, and seals.



By Minette Layne from Seattle, Washington, USA - Single breaching orca (cropped), CC BY 2.0, https://commons.wikimedia.org/w/index.php?curid=3351306

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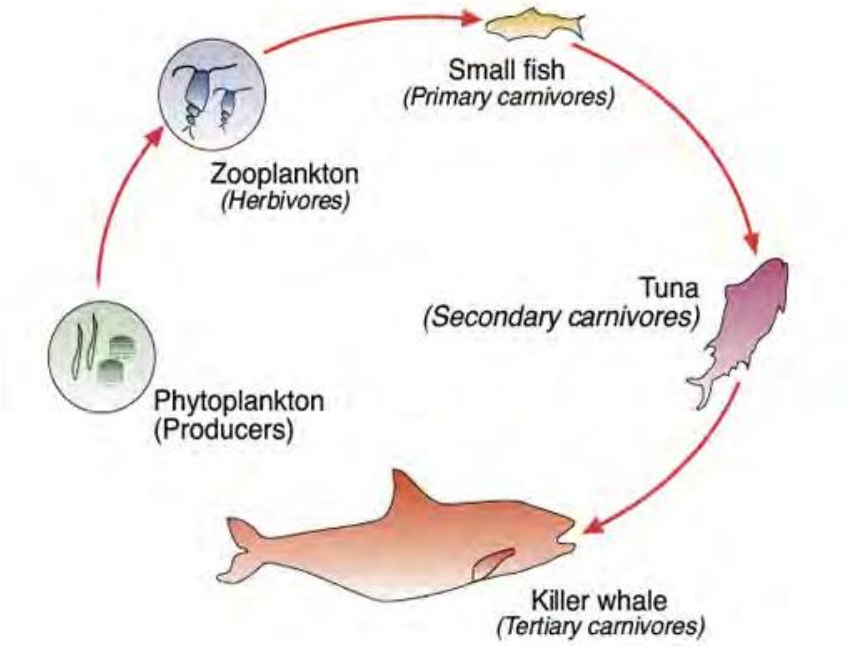


Shark

Neville Coleman

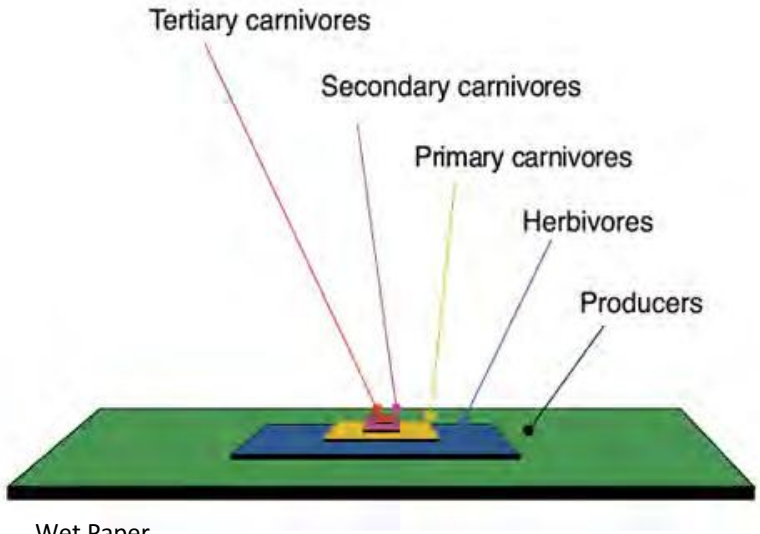
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Trophic levels - the population dynamics



An energy pyramid illustrates how much energy is needed as it flows upward to support the next trophic level.

Each level has a certain biomass - the total amount of living matter per unit of surface or volume, expressed as a weight (g/m^2).



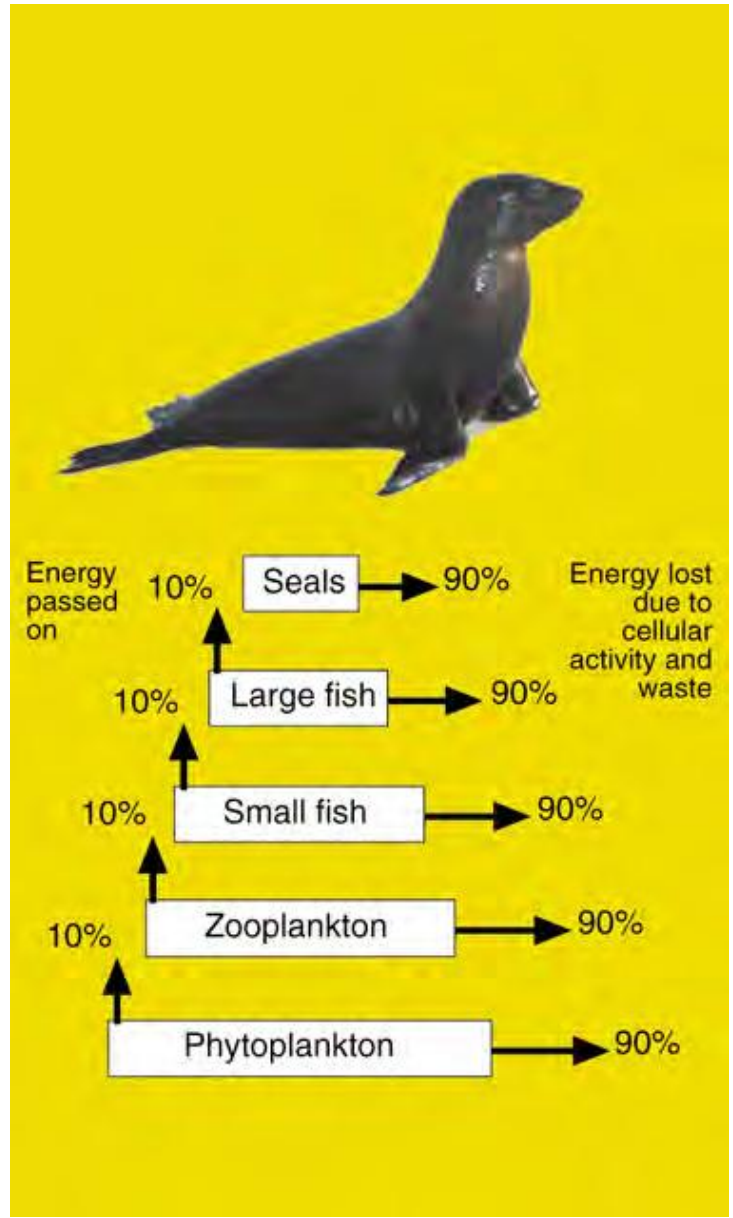
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The higher levels of a food chain will contain smaller amounts of biomass than the previous level.

For example, a certain marine environment may support a producer with a biomass of 1, 000 g/m^2.

The same area may only contain a biomass of herbivores of 50 g/m^2, and 15 g/m^2 of second order consumers.

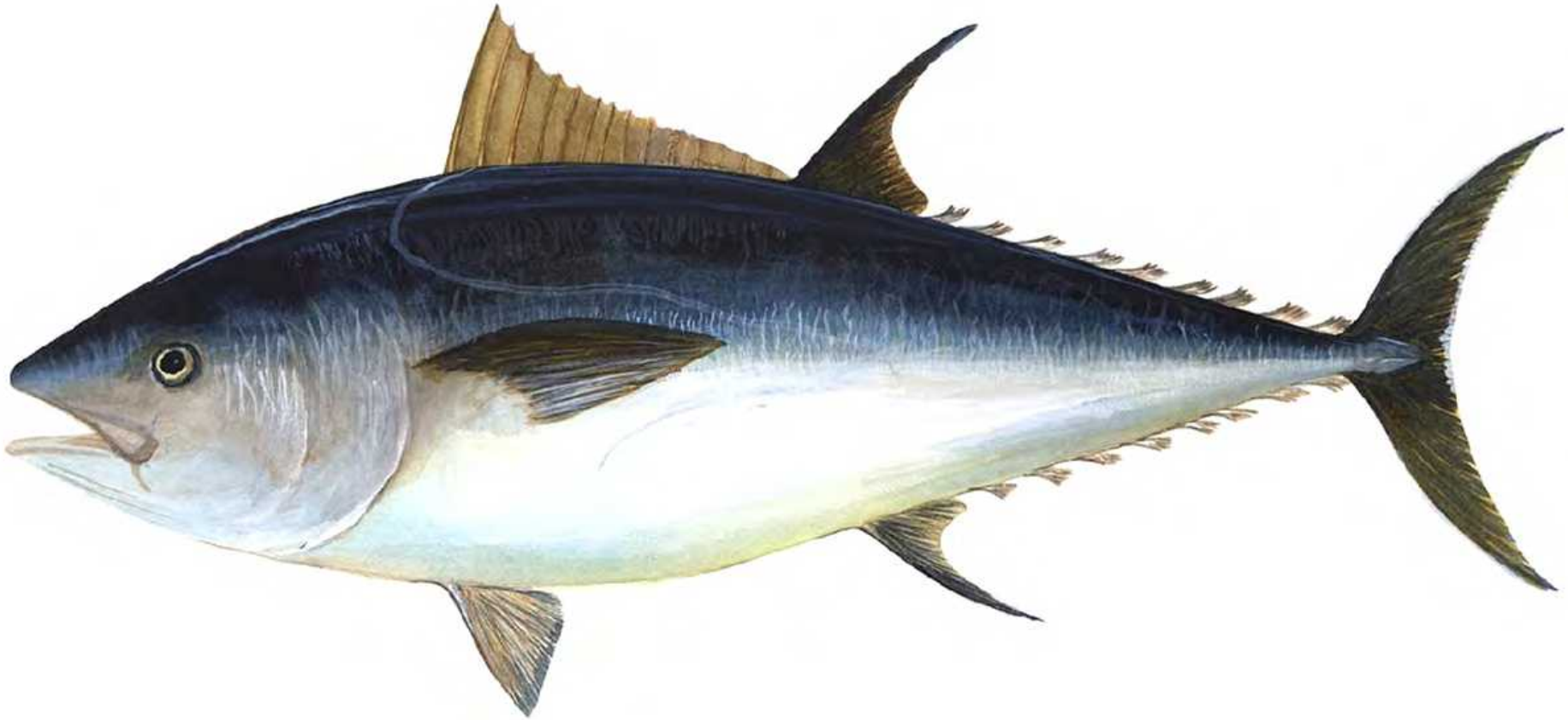
Studies of energy and biomass are important in marine aquaculture as underwater farmers seek to improve their harvest for a world that is discovering the nutritional value of food from the sea.



Wet Paper Seal by Bob Moffatt

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The mean trophic level of the world fisheries catch has steadily declined because many high trophic level fish, such as this tuna, have been overfished.



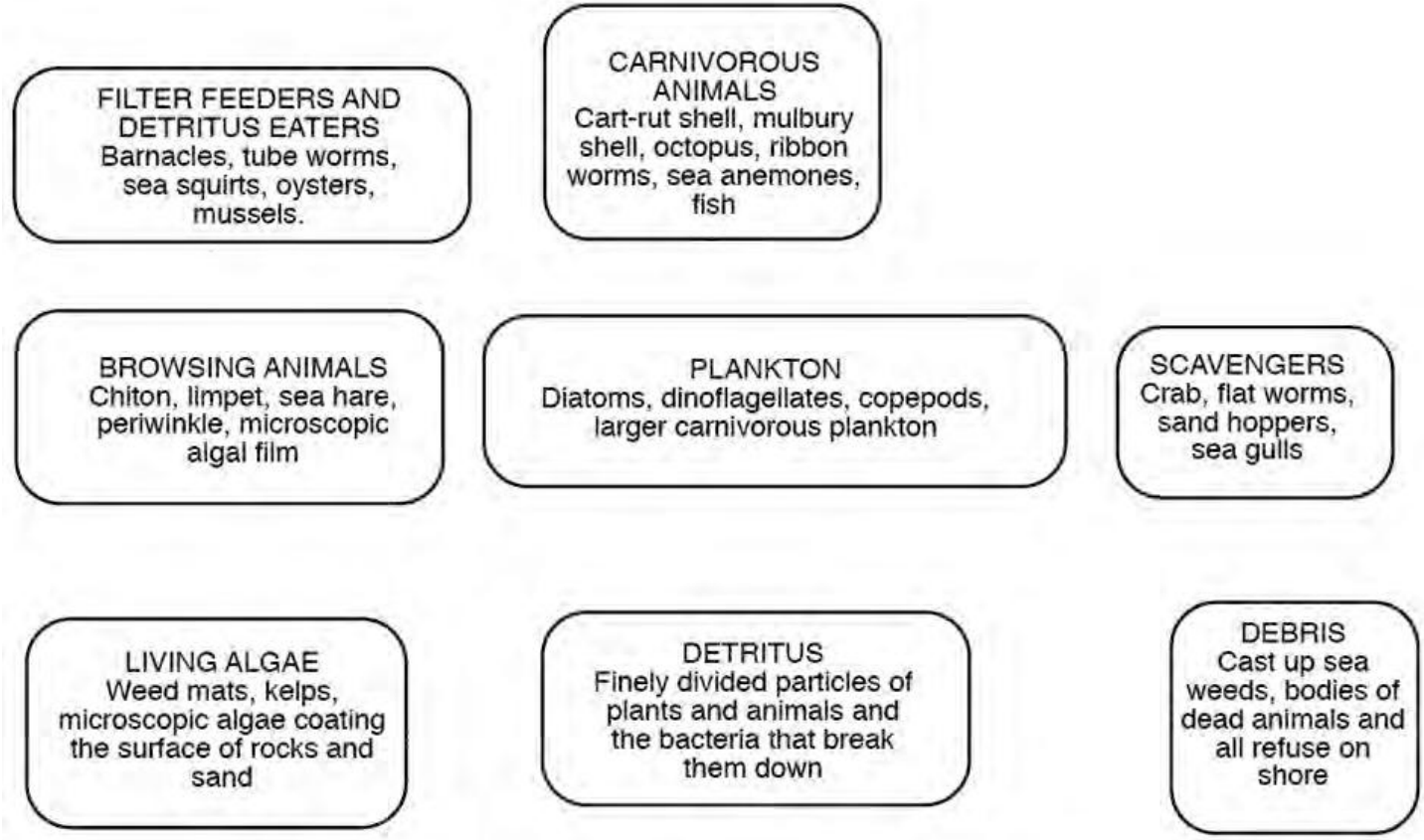
Bluefin Tuna

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Food webs – ways to identify

A food web (or food cycle) is a natural interconnection of food chains and a graphical representation (usually an image) of what-eats-what in an ecological community.

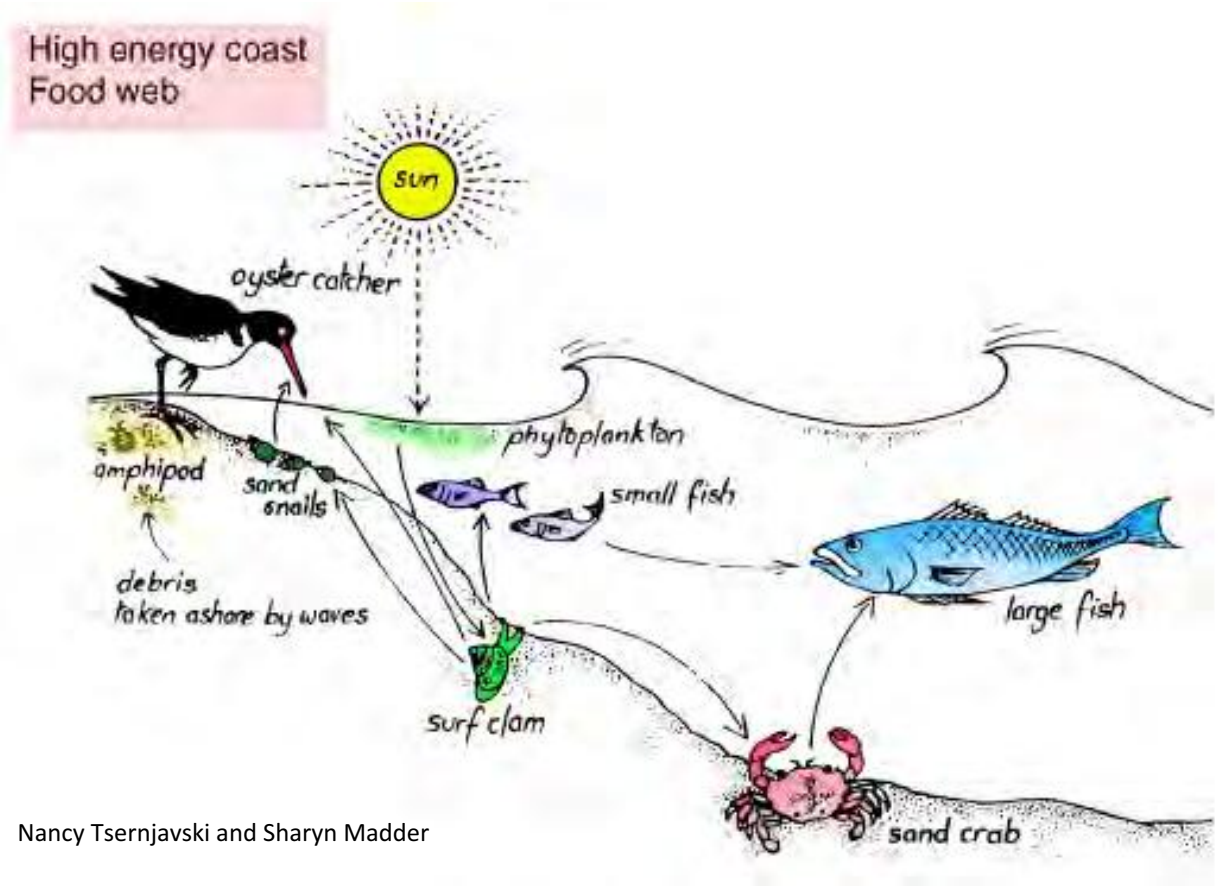


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Food webs – interactions

The linkages in a food web illustrate the feeding pathways (chains), such as where heterotrophs obtain organic matter by feeding on autotrophs and other heterotrophs.

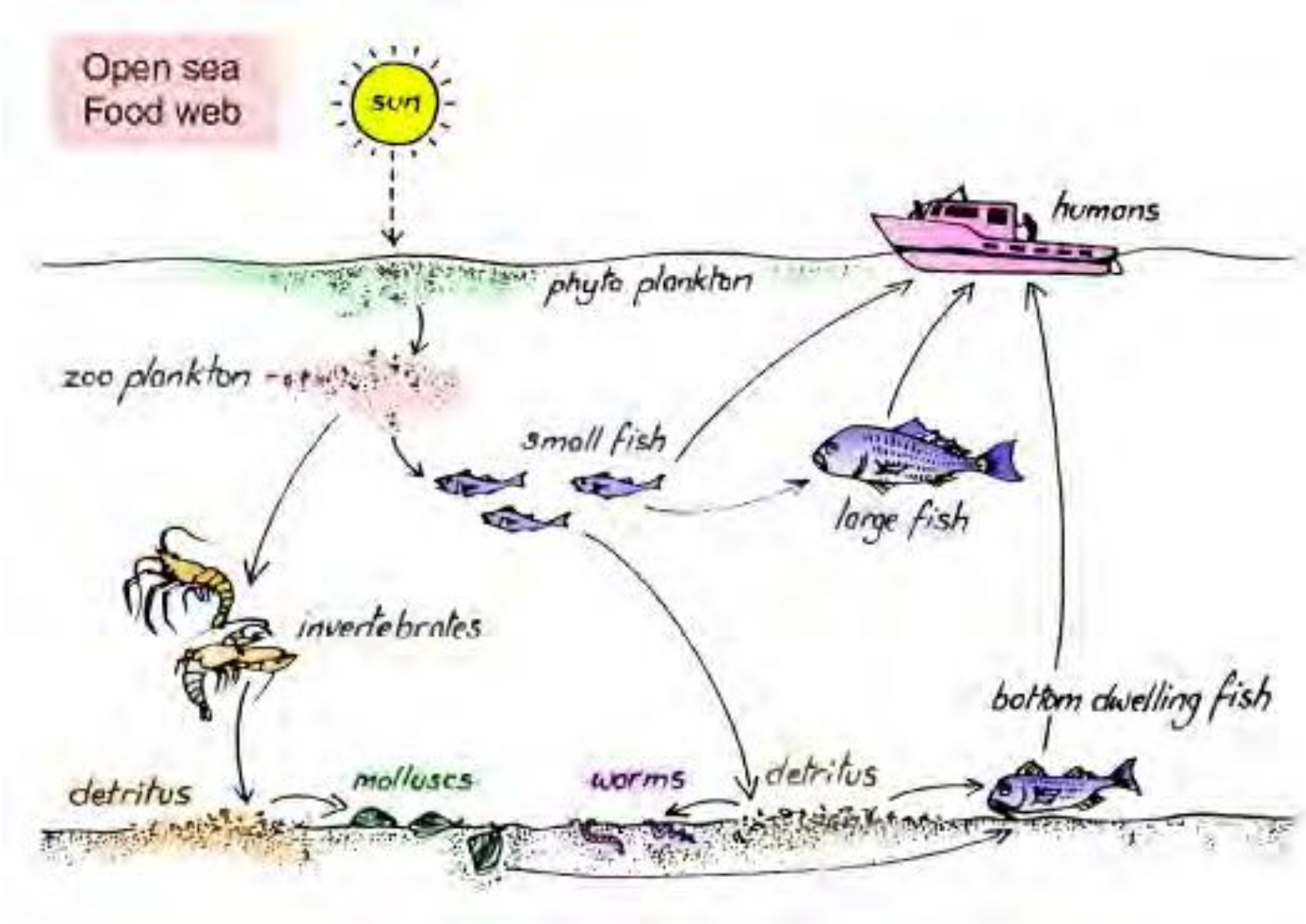


Nancy Tsernjavski and Sharyn Madder

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The food web is a simplified illustration of the various methods of feeding that links an ecosystem into a unified system of exchange.

Some of the organic matter eaten by heterotrophs, such as sugars, provides energy to the rest of the food web.



Nancy Tsernjavski and Sharyn Madder

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Food webs – Population dynamics

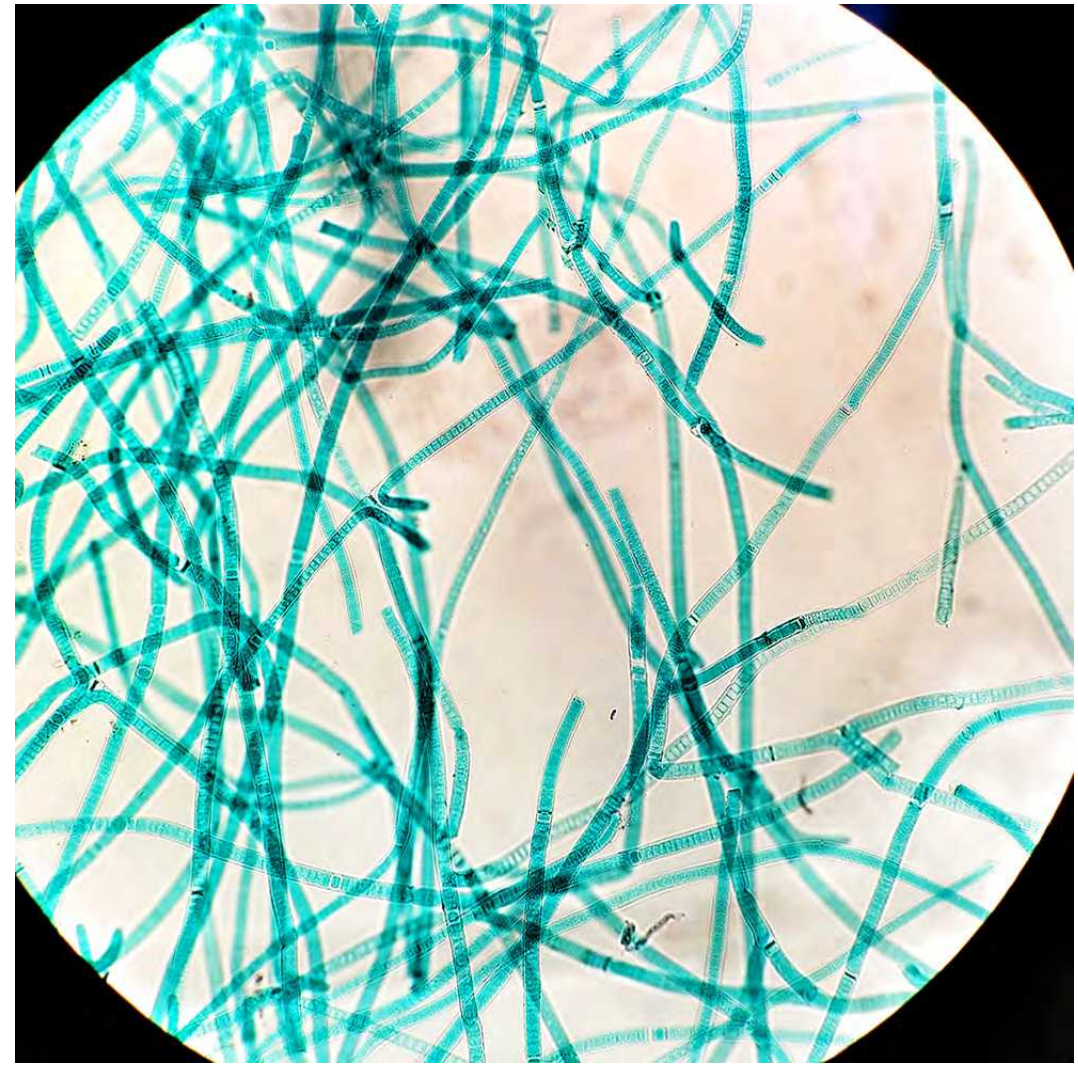
There are different kinds of feeding relations that can be roughly divided into herbivory, carnivory, scavenging and parasitism.



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Autotrophs and heterotrophs come in all sizes, from microscopic to many tonnes - from cyanobacteria to giant mangroves, and from viruses to blue whales.



Cyanobacteria, Tolypothrix

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Population dynamics

Biotic Components vs Abiotic Components

Biotic components are the living things that shape an ecosystem.

Examples of biotic components include animals, plants, fungi, and bacteria. Abiotic components are non-living components that influence an ecosystem. Examples of abiotic factors are temperature, air currents, and minerals.

The factors mentioned above, may either cause an increase or decrease in population sizes, depending on the organism and ecosystem in question.



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Population dynamics and interactions

The next topic discusses how population dynamics is affected by different types of interactions.

For example, how two different species of barnacles compete for space on a rocky shore with one excluding another.

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This is called - Interspecific competition.

When members of different species try to use a resource that is in limited supply (food, light, etc.).

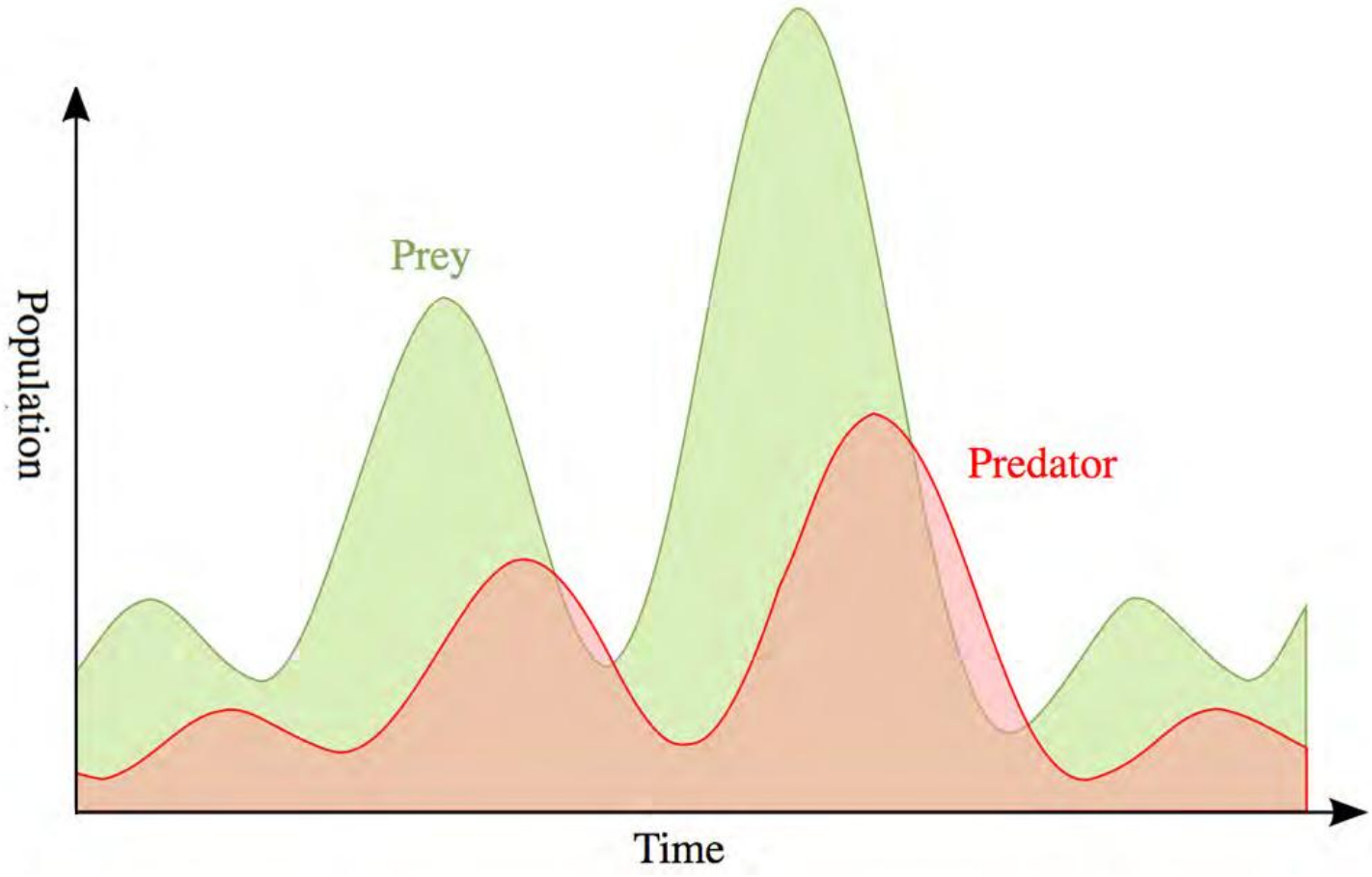
And, you will see the competitive exclusion principle which says,

"No two species can indefinitely occupy the same niche at the same time. The inferior competitor that cannot escape will face extinction"



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Populations of predators and prey can also be part of population dynamics



By Curtis Newton ϟ 10:55, 20. Apr. 2010 (CEST).The original uploader was Lämpel at German Wikipedia. - selbst generiert von Lämpel nach Datei:LotkaVolterra1.gif, CC BY-SA 3.0, https://commons.wikimedia.org/w/index.php?curid=10073271

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Question

Complete the table below to show how you would identify a food chain, trophic level and food web as the biotic components of the marine ecosystem by identifying the component, interactions and population dynamics of each.

Biotic component	Ways to identify component	Interactions	Population dynamics
Food chain			
Trophic level			
Food web			

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End result example

Biotic component	Ways to identify component	Interactions	Population dynamics
Food chain	A food chain is a succession of organisms that eat other organisms and may, in turn, be eaten themselves.	The three basic ways in which organisms get food are as producers, consumers and decomposers. Producers (autotrophs) are typically plants or algae. Plants and algae do not usually eat other organisms, but pull nutrients from the soil or the ocean and manufacture their own food using photosynthesis. For this reason, they are called primary producers. In this way, it is energy from the sun that usually powers the base of the food chain. An exception occurs in deep-sea hydrothermal ecosystems, where there is no sunlight. Here primary producers manufacture food through a process called chemosynthesis. Consumers (heterotrophs) are species that cannot manufacture their own food and need to consume other organisms. Animals that eat primary producers (like plants) are called herbivores. Animals that eat other animals are called carnivores, and animals that eat both plant and other animals are called omnivores. Decomposers (detritivores) break down dead plant and animal material and wastes and release it again as energy and nutrients into the ecosystem for recycling. Decomposers, such as bacteria and fungi (mushrooms), feed on waste and dead matter, converting it into inorganic chemicals that can be recycled as mineral nutrients for plants to use again.	Species Nearly all species are influenced by biotic factors in one way or another. If the number of predators was to increase, the entire food chain would be affected as any prey falling below that specified predator in the food chain will become prey. If the prey is not given enough time by the predator to repopulate, this could not only cause endangerment and extinction in the prey, but the predator as well. Contradicting a decrease in population size, if a particular species reproduces too rapidly, this will cause an increase in population size, thus affecting the environment around them. Pathogens and Disease Outbreaks When disease outbreaks occur, it can be detrimental to an ecosystem. When a disease hits, it will usually affect more than one species, thus causing a serious outbreak. This has the potential to set off a chain reaction thus, causing endangerment to a variety of species within that ecosystem. Human Contact Humans make the most sudden and long-term changes in an environment (e.g. pollution and waste). These changes either drive species out of their territory or force them to adapt to their new surroundings. These changes have the largest impact on an ecosystems population size, typically causing a serious decrease.

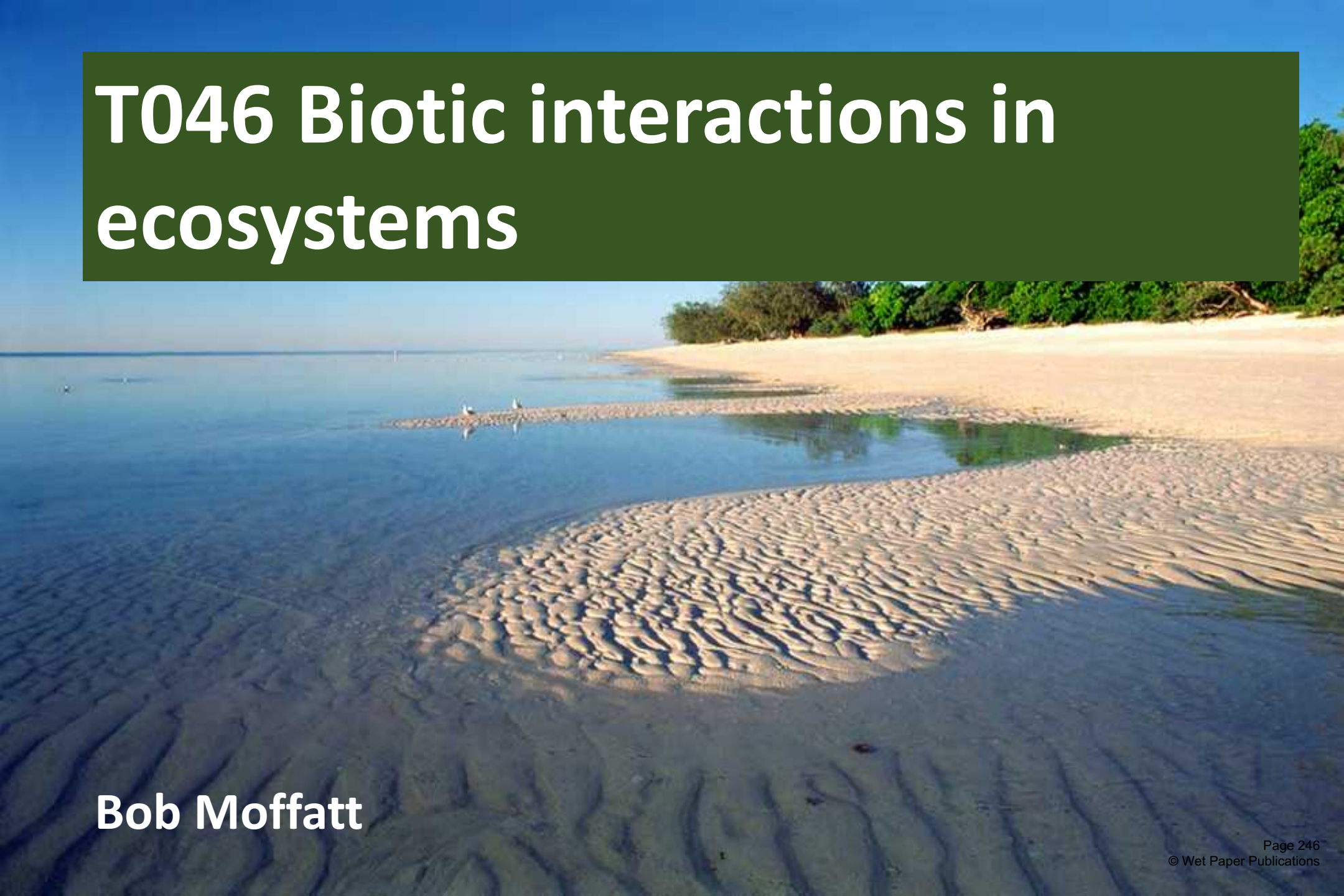
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End result example

Biotic component	Ways to identify component	Interactions	Population dynamics
Trophic level	The trophic level of an organism is the position it occupies in a food chain.	Trophic levels can be represented by numbers, starting at level 1 with plants. Further trophic levels are numbered subsequently according to how far the organism is along the food chain. Level 1: Plants and algae make their own food and are called producers. Level 2: Herbivores eat plants and are called primary consumers. Level 3: Carnivores that eat herbivores are called secondary consumers. Level 4: Carnivores that eat other carnivores are called tertiary consumers. Level 5: Apex predators that have no predators are at the top of the food chain	An energy pyramid illustrates how much energy is needed as it flows upward to support the next trophic level. Each level has a certain biomass - the total amount of living matter per unit of surface or volume, expressed as a weight (g/m2). The higher levels of a food chain will contain smaller amounts of biomass than the previous level. For example, a certain marine environment may support a producer with a biomass of 1, 000 g/m2. The same area may only contain a biomass of herbivores of 50 g/m2, and 15 g/m2 of second order consumers. Studies of energy and biomass are important in marine aquaculture as underwater farmers seek to improve their harvest for a world that is discovering the nutritional value of food from the sea.
Food web	A food web (or food cycle) is a natural interconnection of food chains and a graphical representation (usually an image) of what-eats-what in an ecological community.	The linkages in a food web illustrate the feeding pathways, such as where heterotrophs obtain organic matter by feeding on autotrophs and other heterotrophs. The food web is a simplified illustration of the various methods of feeding that links an ecosystem into a unified system of exchange. Some of the organic matter eaten by heterotrophs, such as sugars, provides energy.	There are different kinds of feeding relations that can be roughly divided into herbivory, carnivory, scavenging and parasitism. Autotrophs and heterotrophs come in all sizes, from microscopic to many tonnes - from cyanobacteria to giant mangroves, and from viruses to blue whales.

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T046 Biotic interactions in ecosystems



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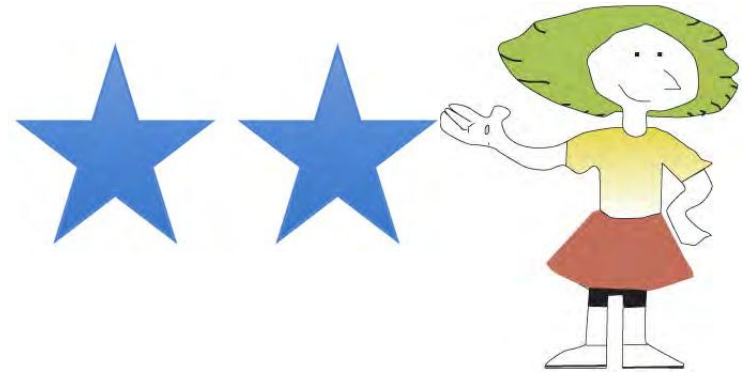
Syllabus statement

At the end of this topic you should be able to ...

Categorise

biotic interactions based on the following terms:

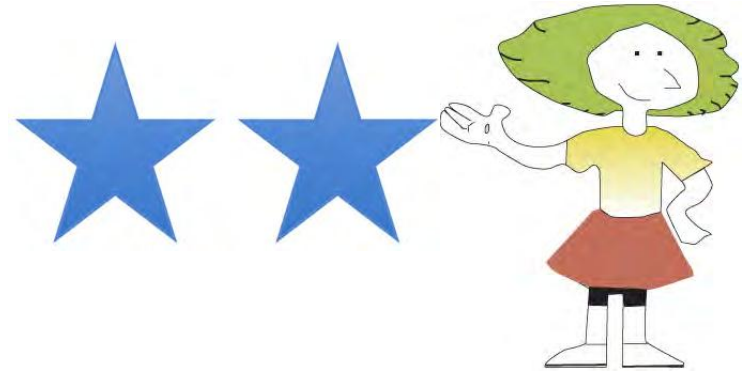
- symbiosis (i.e. parasitism, mutualism, commensalism and amensalism)
- competition (i.e. intraspecific and interspecific)
- predation



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Categorise

- place in or assign to a particular class or group;
- arrange or order by classes or categories;
- classify, sort out, sort, separate



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Objective

Classify a group of individuals into either symbiotic, competitive or predatory, based on a set of criteria.

•symbiosis (i.e. parasitism, mutualism, commensalism and amensalism)

•competition (i.e. intraspecific and interspecific)

•predation

References used

https://en.wikipedia.org/wiki/Symbiosis https://en.wikipedia.org/wiki/Parasitism
https://en.wikipedia.org/wiki/Mutualism_(biology)
https://en.wikipedia.org/wiki/Commensalism
https://en.wikipedia.org/wiki/Symbiosis#Amensalism

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Definition

Symbiosis (from the Greek "living together”),

is any type of a close and long-term biological interaction between two different biological organisms

be it,

- Parasitism
- Mutualism
- Commensalism or
- Amensalism



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Parasitism

Parasitism is a relationship between species, where one organism, the parasite benefits by living on or in another organism, the host, causing it harm, and is adapted structurally to this way of life.



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Example

A Lithognathus fish with a parasitic isopod, Cymothoa exigua, a fish parasite replacing its tongue.



By Marco Vinci - Own work, CC BY-SA 3.0, https://commons.wikimedia.org/w/index.php?curid=30119814

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Mutualism

Mutualism is the way two organisms of different species exist in a relationship in which each individual benefits from the activity of the other.



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Example

The clownfish and sea anemone is a mutual **service-service** symbiosis.

The fish driving off butterfly and zebra fish and the anemone's tentacles protecting the clownfish from predators.



Viewfinder

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Commensalism

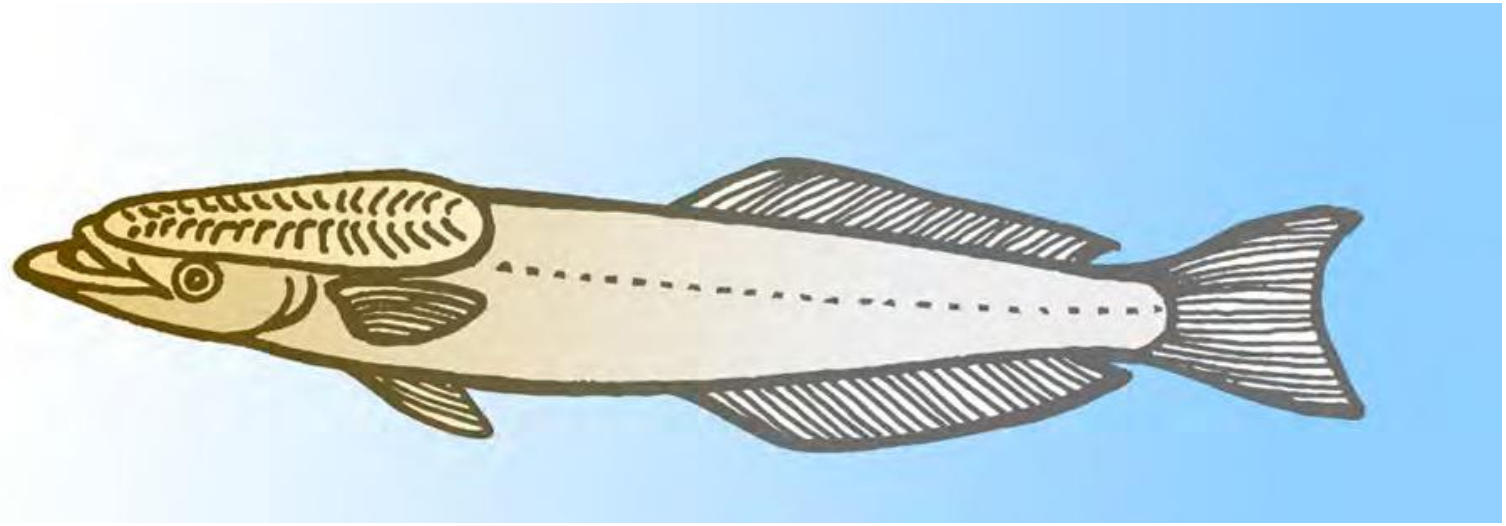
Commensalism is a long term biological interaction (symbiosis) in which members of one species gain benefits, while those of the other species, are neither benefited nor harmed.



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Example

Remora are specially adapted to attach themselves to larger fish that provide locomotion and food.



Steven Byers

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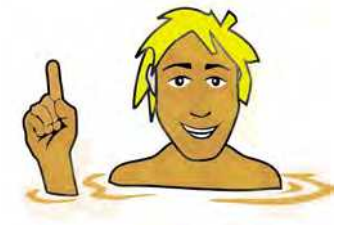


By Duncan Wright (User:Sabine's Sunbird) - en: Image:Nurse shark with remoras.jpg, CC BY-SA 3.0, https://commons.wikimedia.org/w/index.php?curid=1263876

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Amensalism

Amensalism is an asymmetric interaction where one species is harmed or killed by the other, and one is unaffected by the other.



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Example

Humans who pollute the sea with fishing nets, plastic bags, algae which secrete chemicals to inhibit the growth of those nearby or algal blooms that kill large numbers of fish.

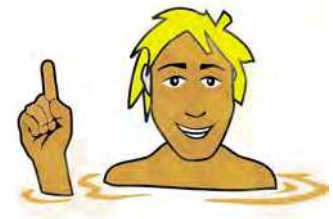


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Competition

Competition is an interaction between organisms or species in which both of the organisms or species are harmed.



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Example

Sea anemones compete for territory in tidal pools.



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Intraspecific competition

Intraspecific competition occurs when members of the same species compete for the same resources in an ecosystem.



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Example

Male elephant seals engage in fierce competitive displays in an attempt to control a large harem of females for breeding.



"Mike" Michael L. Baird [CC BY 2.0 (https://creativecommons.org/licenses/by/2.0)], via Wikimedia Commons
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Interspecific competition

Interspecific competition occurs when individuals of different species compete for the same resources in an ecosystem (e.g. food or living space).

Importance

A study of interspecific competition can show how one species can exclude another from an area.

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An American ecologist Joseph Connell showed this in a now famous barnacle experiment.

He showed the effect of two different species of barnacles competing for space on a rocky shore with one excluding the other from a zone.

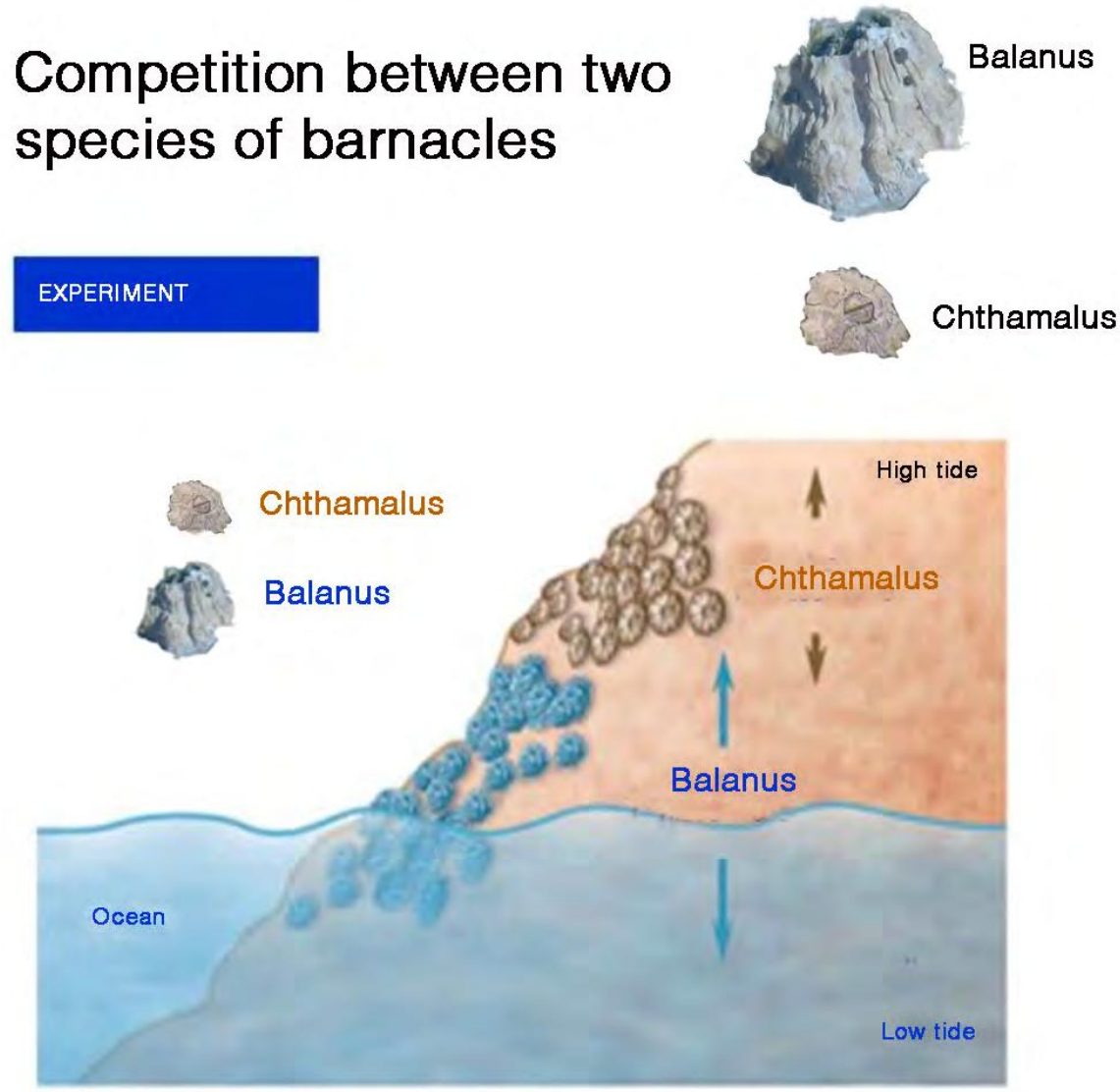


Illustration Bob Moffatt (After Connell 1923)

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Experiment 1:

Connell removed small barnacles from the upper area and no big barnacles replaced it.

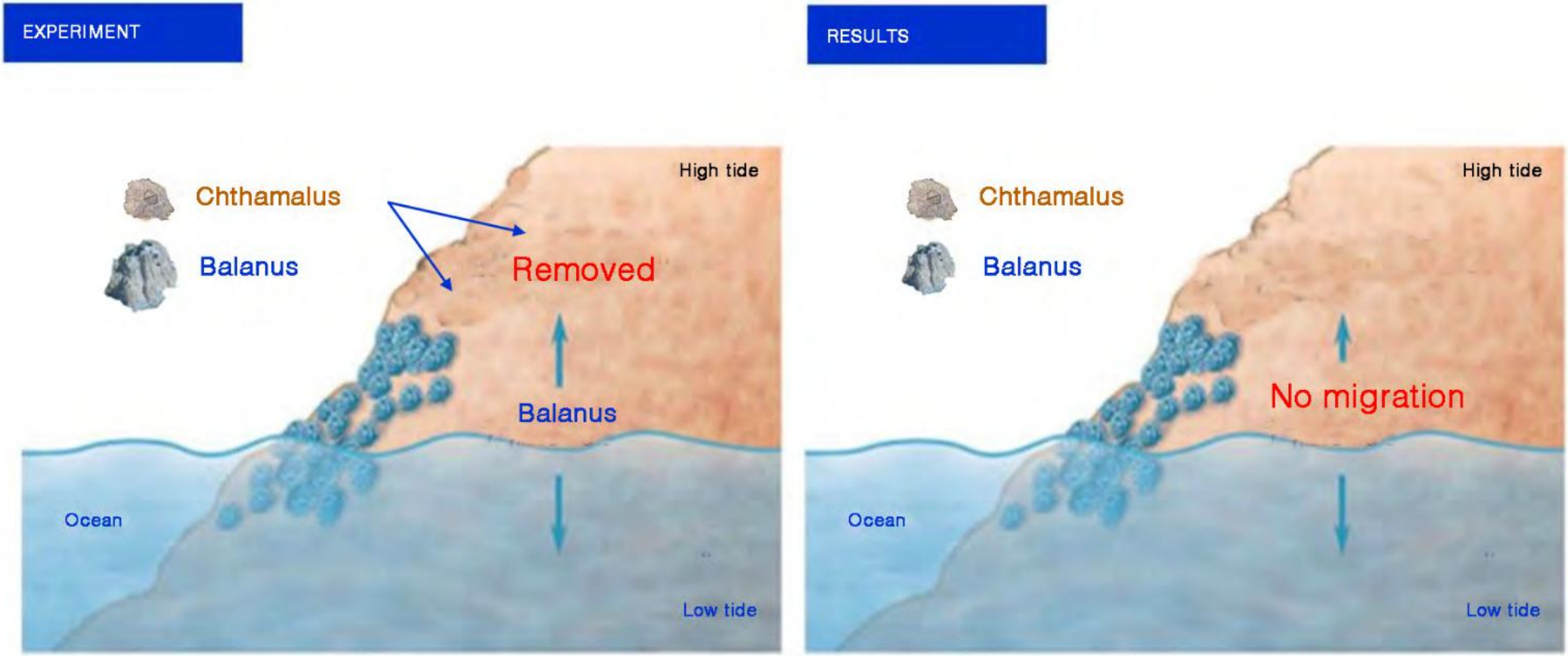


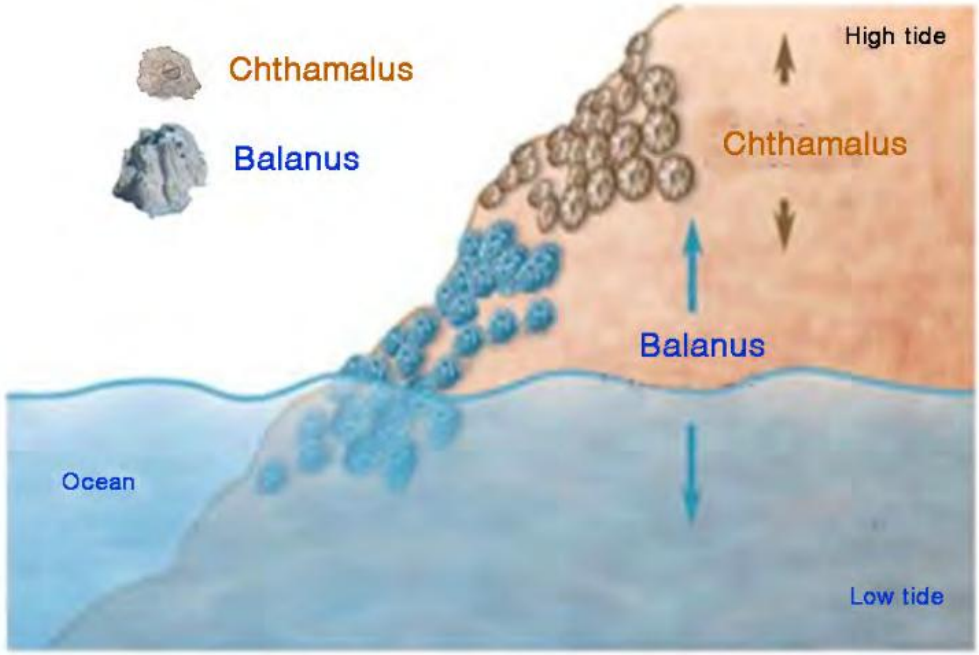
Illustration Bob Moffatt (After Connell 1923)

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Experiment 2:

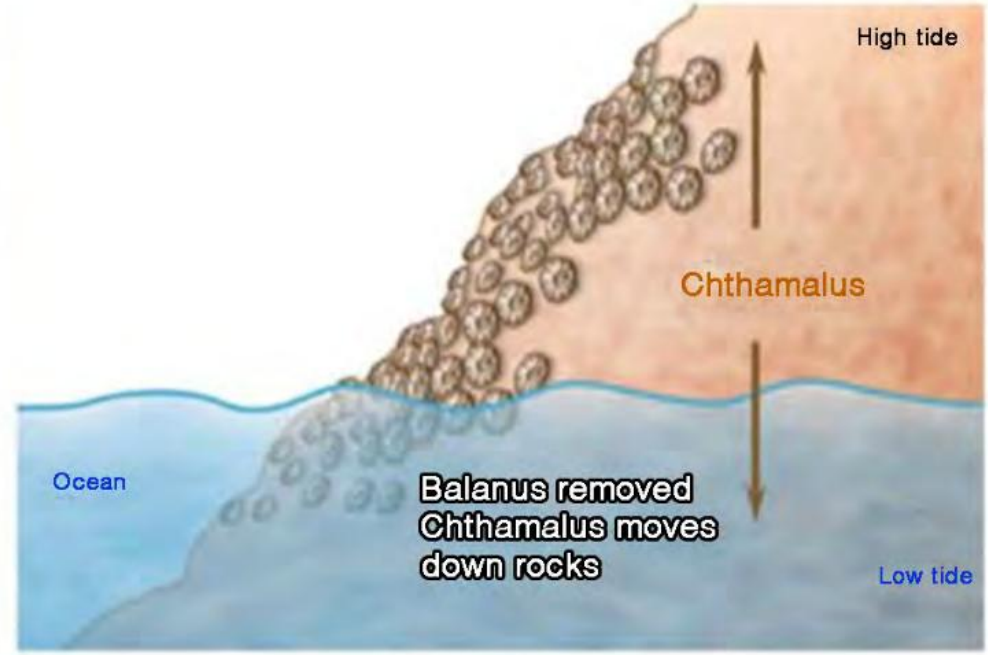
Connell removed big barnacles from the lower area and the small barnacles replaced it.

EXPERIMENT



Balanus was removed from the lower strata of rocks.

RESULTS



CONCLUSION

The smaller barnacle's distribution is limited by interspecific competition.

Illustration Bob Moffatt (After Connell 1923)

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This lead to the competitive exclusion principle which says:

"No two species can indefinitely occupy the same niche at the same time. The inferior competitor that cannot escape will face extinction."



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You will learn more about a niche under the topic:

Recall

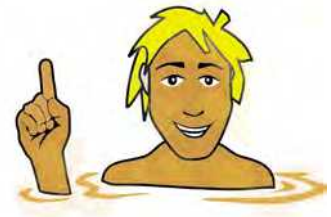
the terms population size, density, abundance, distribution (i.e. clumped, uniform, random), carrying capacity, niche, K-strategists and r-strategists, keystone species



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Interspecific competition

Interspecific competition occurs when individuals of different species compete for the same resources in an ecosystem (e.g. food or living space).



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Example

Plants in a sand dune compete for the same nutrients in the sand.



Bob Moffatt

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Predation

Predation is a biological interaction where a predator (a hunting animal) kills and eats its prey (the organism that is attacked).

Predators can be apex or non-apex.



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Apex predator

An apex predator, also known as an alpha predator or top predator, is a predator at the top of a food chain, with no natural predators

Example

The saltwater crocodile is the largest living reptile and the dominant predator throughout its range.



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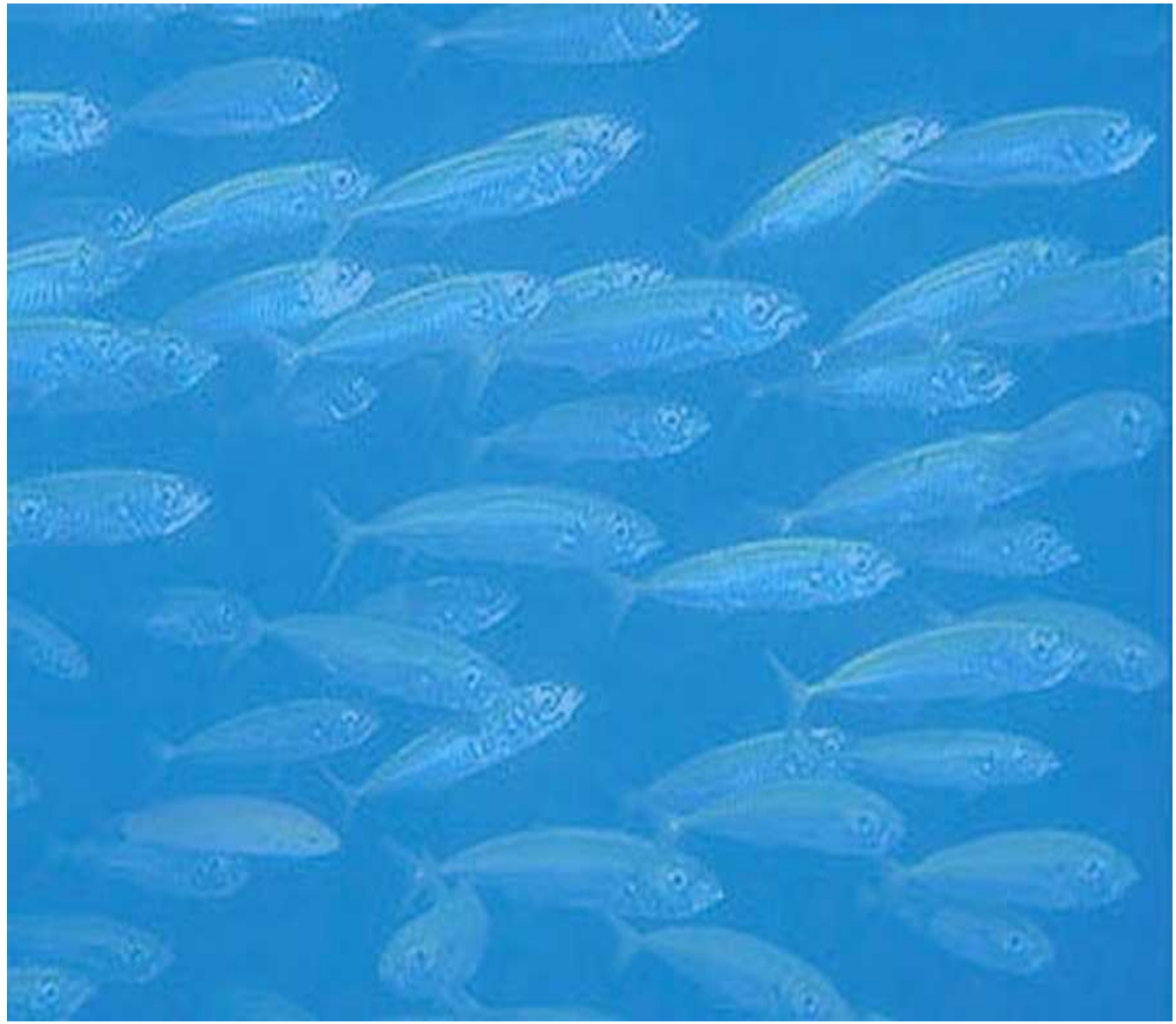
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Non-apex predators

All other predators are those below the apex predator.

A fish eats copepods.

Both are below the crocodile, who is the apex predator.



Below H_20

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Question

Complete the table below to show how you would categorise organisms into either symbiotic, competitive or predatory relationships listing commonly used criteria, giving a commonly recognised subcategory and providing an example of each.

Relationship			
Symbiotic	Sub category	Criteria	Example
	Parasitism		
	Mutualism		
	Commensalism		
	Amensalism		
Competition	Sub category	Criteria	Example
	Intraspecific		
	Interspecific		
Predation	Sub category	Criteria	Example
	Apex		
	All others		

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End result example

Relationship			
Symbiotic is any type of a close and long-term biological interaction between two different biological organisms	Sub category	Criteria	Example
	Parasitism	Parasitism is a relationship between species, where one organism, the parasite, lives on or in another organism, the host, causing it some harm, and is adapted structurally to this way of life	A fish with a parasitic isopod replacing its tongue.
	Mutualism	Mutualism is the way two organisms of different species exist in a relationship in which each individual benefits from the activity of the other.	The clownfish and sea anemone is a mutual service-service symbiosis, the fish driving off butterfly fish and the anemone's tentacles protecting the fish from predators.
	Commensalism	Commensalism is a long term biological interaction (symbiosis) in which members of one species gain benefits while those of the other species are neither benefited nor harmed	Remora are specially adapted to attach themselves to larger fish that provide locomotion and food.
	Amensalism	Amensalism is an asymmetric interaction where one species is harmed or killed by the other, and one is unaffected by the other.	Humans who pollute the sea with plastic bags, algae which secrete chemicals to inhibit the growth of those nearby.
Competition is an interaction between organisms or species in which both the organisms or species are harmed.	Sub category	Criteria	Example
	Intraspecific	Intraspecific competition occurs when members of the same species compete for the same resources in an ecosystem.	Male elephant seals engage in fierce competitive displays in an attempt to control a large harem of females.
	Interspecific	Interspecific competition occurs when individuals of different species compete for the same resources in an ecosystem (e.g. food or living space).	Plants in a sand dune compete for the same nutrients in the sand.
Predation Predation is a biological interaction where a predator (a hunting animal) kills and eats its prey (the organism that is attacked).	Sub category	Criteria	Example
	Apex	An apex predator, also known as an alpha predator or top predator, is a predator at the top of a food chain, with no natural predators	The saltwater crocodile is the largest living reptile and the dominant predator throughout its range.
	All others	All other predators are those below the apex predator	A fish eat copepod which is below the crocodile who is the apex predator.

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T047 Trophic level classifications



Bob Moffatt

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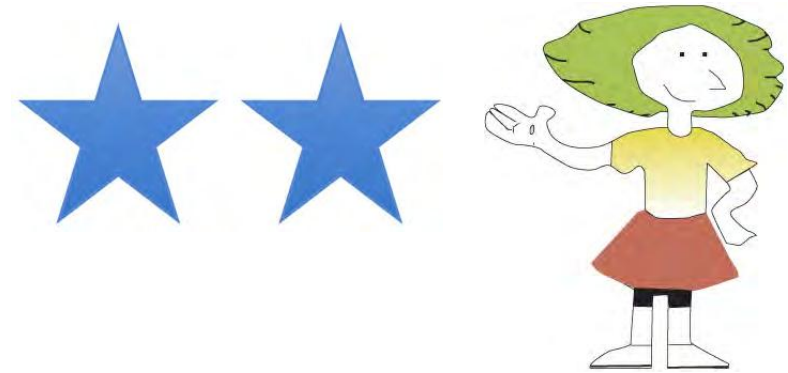
Syllabus statement

At the end of this topic you should be able to ...

Classify

organisms in trophic levels, in a food web, based on the following terms:

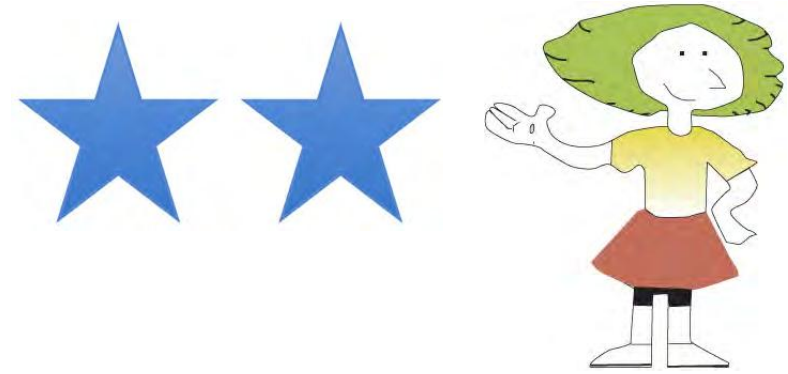
- Producers
- Primary (first order) consumers
- Secondary consumers
- Tertiary consumers
- Decomposers



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Classify

Arrange distribute or order in classes or categories according to shared qualities or characteristics.



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Objective

Classify a group of individuals from a trophic level, in a food web, into:

- Producers
- Primary consumers
- Secondary consumers
- Tertiary consumers
- Decomposers

References used

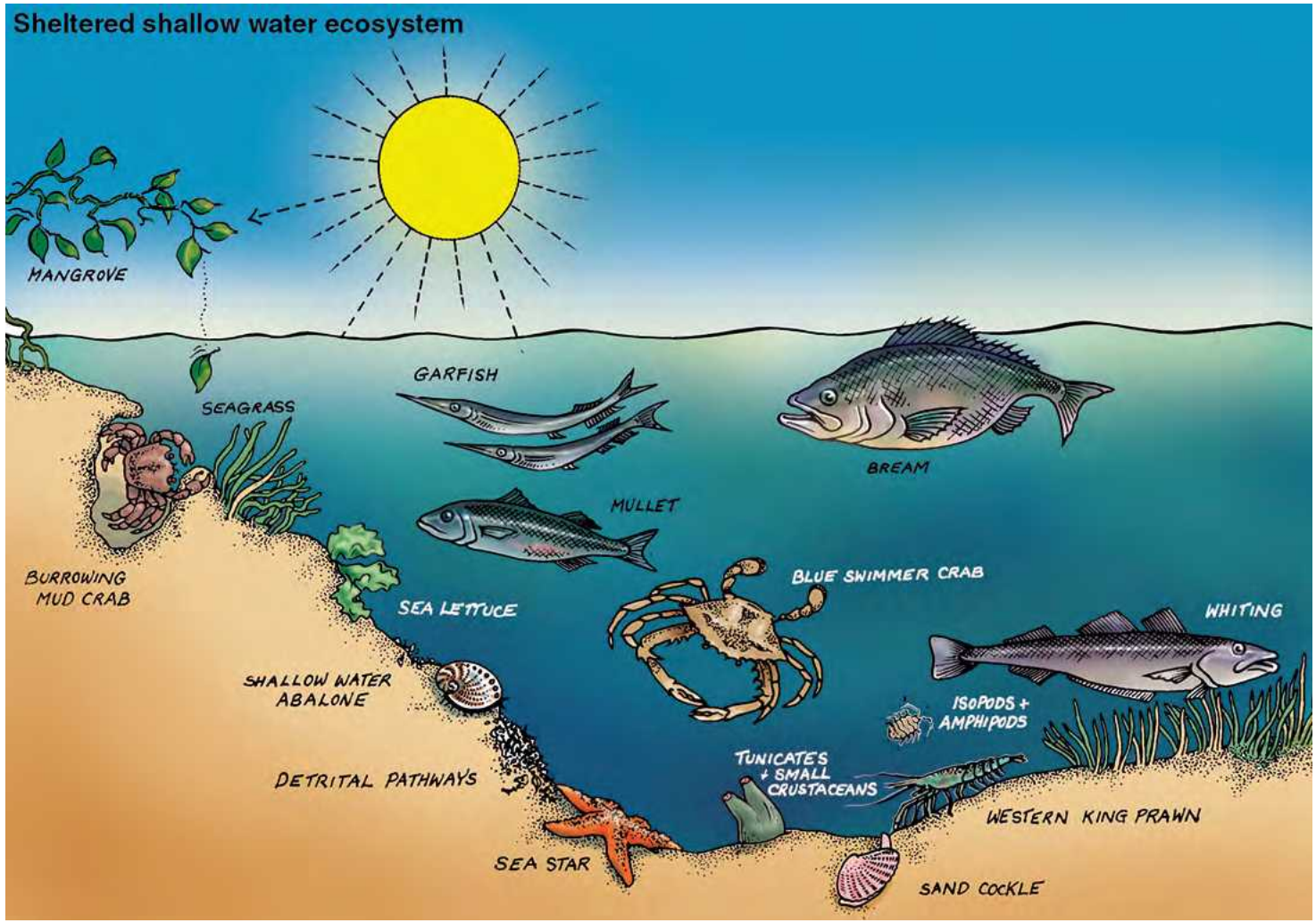
https://en.wikipedia.org/wiki/Food_web
https://en.wikipedia.org/wiki/Producer
https://en.wikipedia.org/wiki/Consumer
https://en.wikipedia.org/wiki/Decomposer



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Definition – food web

A food web is a natural interconnection of food chains and a graphical representation of what-eats-what in an ecological community.



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Bob Moffatt (Photographed Currumbin reserve)

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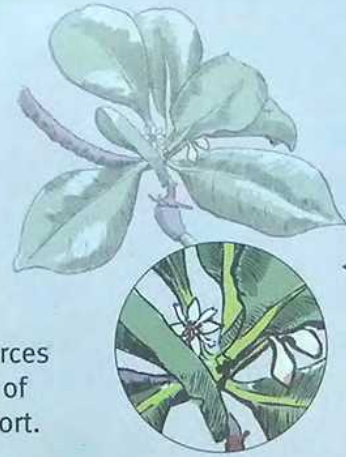
Traditional people's **supermarket** and **pharmacy**

Mangroves supplied important food and medicine to the Kombumerri Aboriginal people.

Can you read signs without words?

Indigenous people could 'read' environmental signs and knew that certain events (such as paperbark trees' flowering) heralded another food supply.

Indigenous people planned large festivals and gatherings at times when local food sources were peaking. This way a crowd of hundreds of people could be catered for with minimal effort.



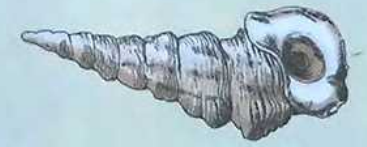
Grey mangrove *Avicennia marina*
Kombumerri people would use the sap from this tree to help ease constipation.



Red mangrove *Rhizophora stylosa*
These white flowers indicate the time when oysters (Kinyingurra) are fat, juicy and ready to eat.



Kinyingurra
Oyster shells make up a large part of estuarine shell mounds. Though only edible in season, they were much sought after in mangroves and on rocky reefs.



Mud whelks
Common in mangrove swamps and on mud flats in this region. They were eaten throughout the year.



Periwinkle

Throughout the seasons a rich variety of food was gathered, such as:

Spring	Summer	Autumn	Winter
sea mullet	oysters	cod	tailor
prawns	cockles	jewfish	sea mullet
crabs	flathead	black bream	black bream
yams	shrimp	mangrove jack	
honey (from native bees)		goannas	
		yams	

Special thanks to the Kombumerri people for sharing their knowledge.

Queensland Parks and Wildlife Service
Department of Environment and Resource Management

Queensland Government

Bob Moffatt (Photographed Currumbin reserve)

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Producer

An organism that produces its own food from inorganic matter present in the environment, through photosynthesis
or,
in the deep sea, through chemosynthesis.



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Marine algae are producers.



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Spinifex and mangroves are producers.



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Coastal plants like banksia, are producers.



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Primary consumer

Primary consumers are herbivores, feeding on plants or detritus.



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Secondary consumer

Secondary consumers are organisms that eat primary consumers for energy.

Primary consumers are always herbivores, or organisms that only eat autotrophic plants.

However, secondary consumers can either be carnivores or omnivores.

Carnivores only eat other animals, and omnivores eat both plant and animal matter.

Regardless of what a secondary consumer is, it still must have primary consumers in its diet to survive.



Parrotfish

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Analysis of parrotfish feeding biology describes three functional groups: excavators, scrapers and browsers.

Excavators have larger, stronger jaws that excavate the substrate, leaving visible scars—even gouges—on the surface.

Scrapers have less powerful jaws that can but infrequently do leave visible scraping scars on the substrate. Some of these may also feed on sand instead of hard surfaces.

Browsers mainly feed on seagrasses and their epiphytes.



Reference

https://en.wikipedia.org/wiki/Parrotfish

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Tertiary consumer

Tertiary consumers eat the secondary consumers, though they may also feed on primary consumers.



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Some animals can be even higher up the food chain such as killer whales as they can eat seals.



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Quaternary consumer

Killer whales are then classified as quaternary consumers on five level food webs, eating seals who are tertiary consumers.



By Minette Layne from Seattle, Washington, USA - Single breaching orca (cropped), CC BY 2.0, https://commons.wikimedia.org/w/index.php?curid=3351306

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Scavangers

Many animals eat particles of dead plants and animals in a process called scavanging.



Great white shark scavanges on dead whale.

By Fallows C, Gallagher AJ, Hammerschlag N (2013) - Fallows C, Gallagher AJ, Hammerschlag N (2013) White Sharks (Carcharodon carcharias) Scavenging on Whales and Its Potential Role in Further Shaping the Ecology of an Apex Predator. PLoS ONE 8(4): e60797. doi:10.1371/journal.pone.0060797, CC BY 2.5, https://commons.wikimedia.org/w/index.php?curid=25544671

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Scavenging is the process in which animals consume dead prey or plant material that have died from causes other than predation.

As both a carnivorous and herbivorous feeding behavior, scavenging aids in overcoming fluctuations in food resources in the environment.

Scavengers play an important role in the ecosystem by consuming the dead animal and plant material.



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Soldier crabs will scoop up sand and mud with their front claws. They sift through the sand for food, dropping unwanted sand and mud



Bob Moffatt

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In estuaries oyster catchers feed on bivalves, gastropods and polychaete worms..



Bob Moffatt

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Decomposer

Decomposers are organisms that break down dead or decaying organisms, and in doing so, they carry out the natural process of decomposition.



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A lichen on a mangrove is a decomposer.



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Another example of a decomposer is a marine worm, the *Parborlasia corrugatus* lives at depths of up to 4,000 metres.



By Henry Kaiser, National Science Foundation - http://www.usap.gov/; exact source, Public Domain, https://commons.wikimedia.org/w/index.php?curid=5031472

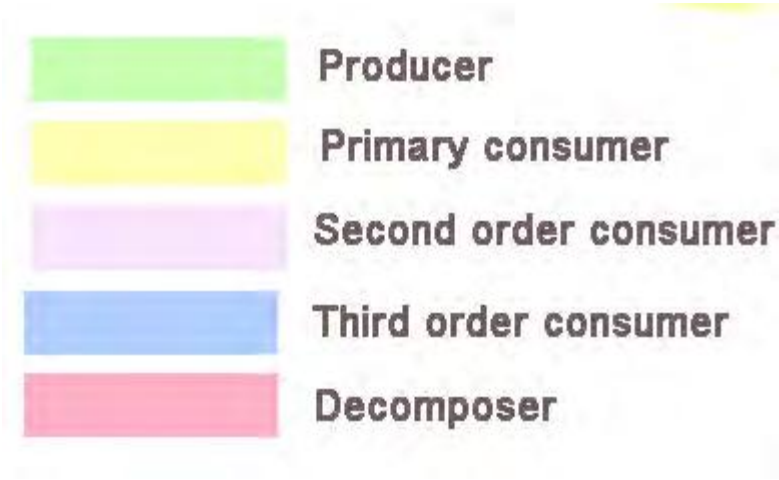
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We have to classify

organisms into trophic levels, in a food web, based on the following terms:

- Producers
- Primary (first order) consumers
- Secondary consumers
- Tertiary consumers
- Decomposers

So let's use 5 colours to do so!



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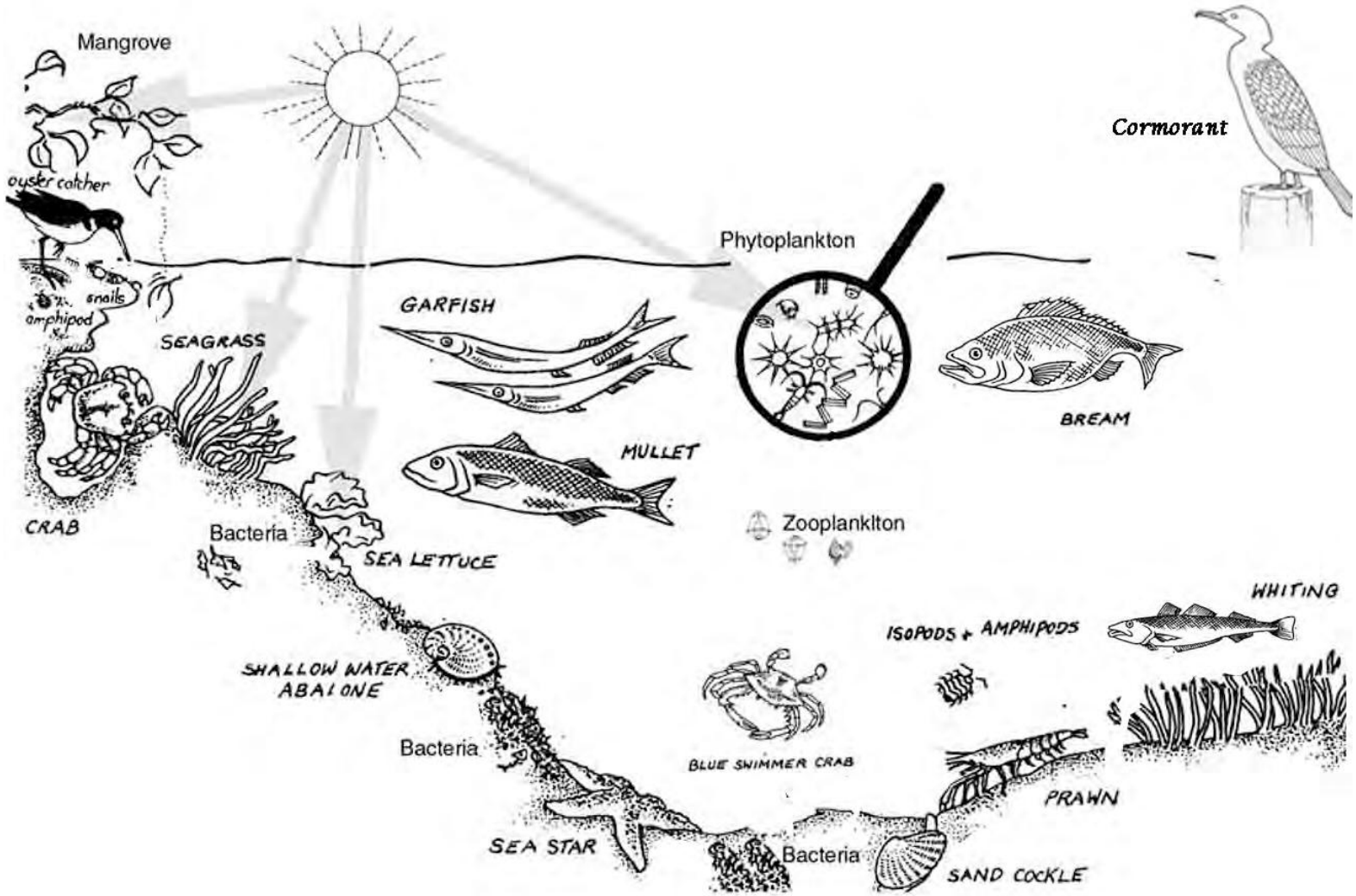
Questions

Q1. Define the terms food web, producer, primary consumer, secondary consumer, tertiary consumer and decomposer.

Term	Definition
Food web	
Producer	
Primary consumers	
Secondary consumers	
Tertiary consumers	
Decomposers	

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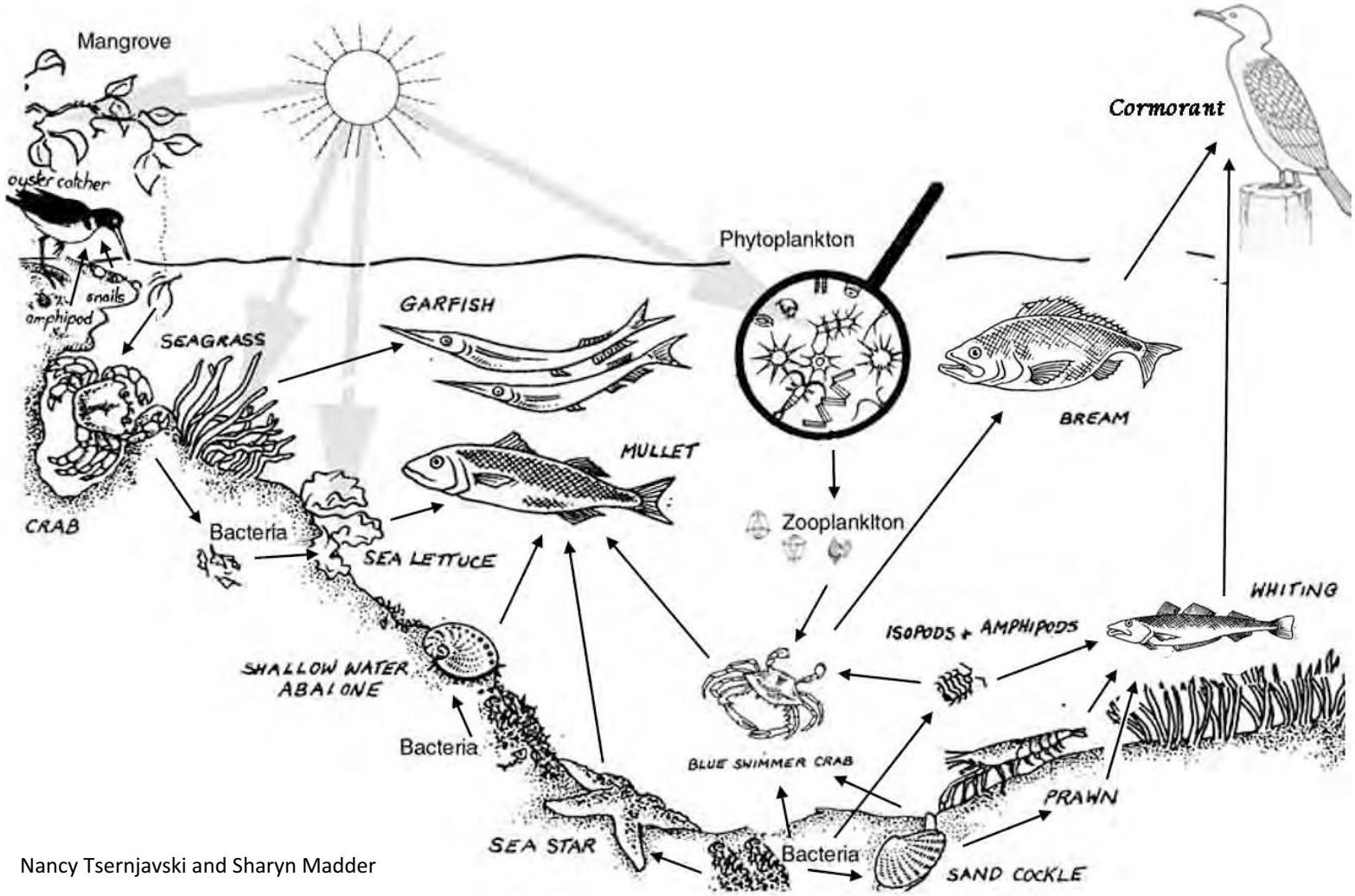
Q2. Now classify the marine organisms from the food web below as either producer, consumer or decomposer into the table.



Nancy Tsernjavski and Sharyn Madder

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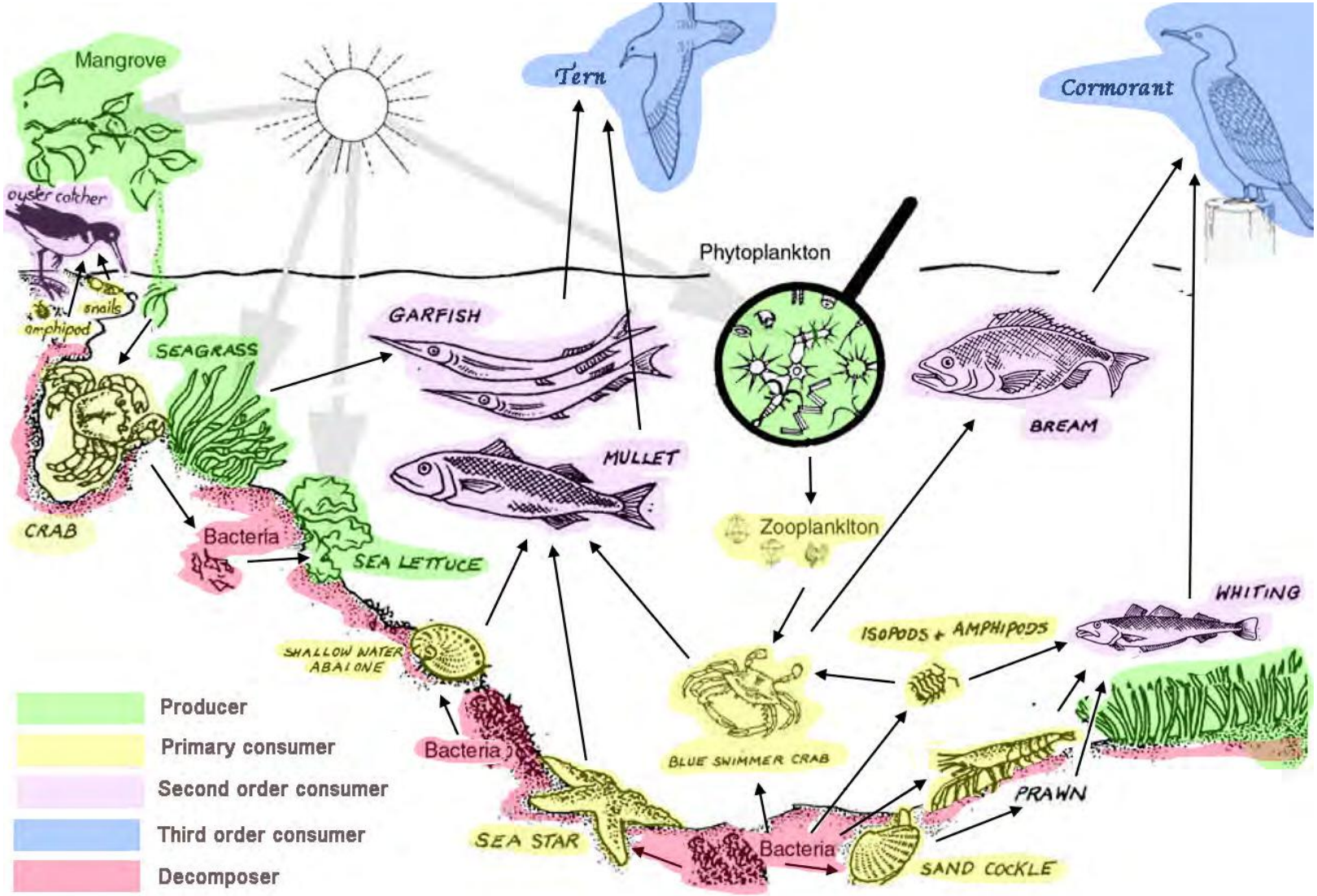
Q3. Now classify (using colour) the marine organisms from the food web as either producer (green) first order consumer (yellow) or second order consumer (purple), third order consumer (blue) Decomposer (red) in the table.



Nancy Tsernjavski and Sharyn Madder

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Then classify the trophic levels



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T048 Food web matter cycling



Bob Moffatt

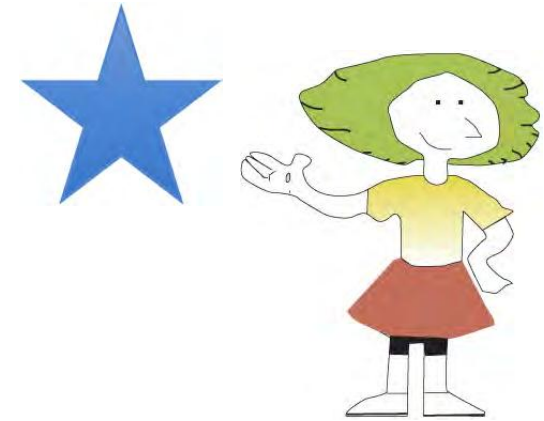
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Syllabus statement

At the end of this topic you should be able to ...

Describe

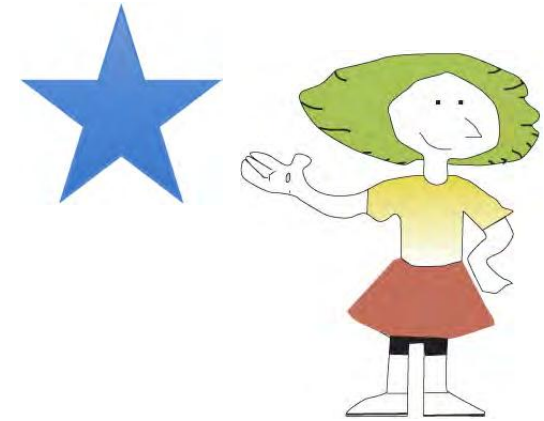
how matter cycles through food webs, including the process of bioaccumulation



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Describe

give an account (written or spoken) of a situation, event, pattern or process, or of the characteristics or features of something



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Objectives

1.Describe how matter cycles through an estuarine food web in the nitrogen and phosphorus cycles

1. Describe how the introduction of a toxin such as ciguateria causes bioaccumulation in the food chain.

References used
https://en.wikipedia.org/wiki/Food_web

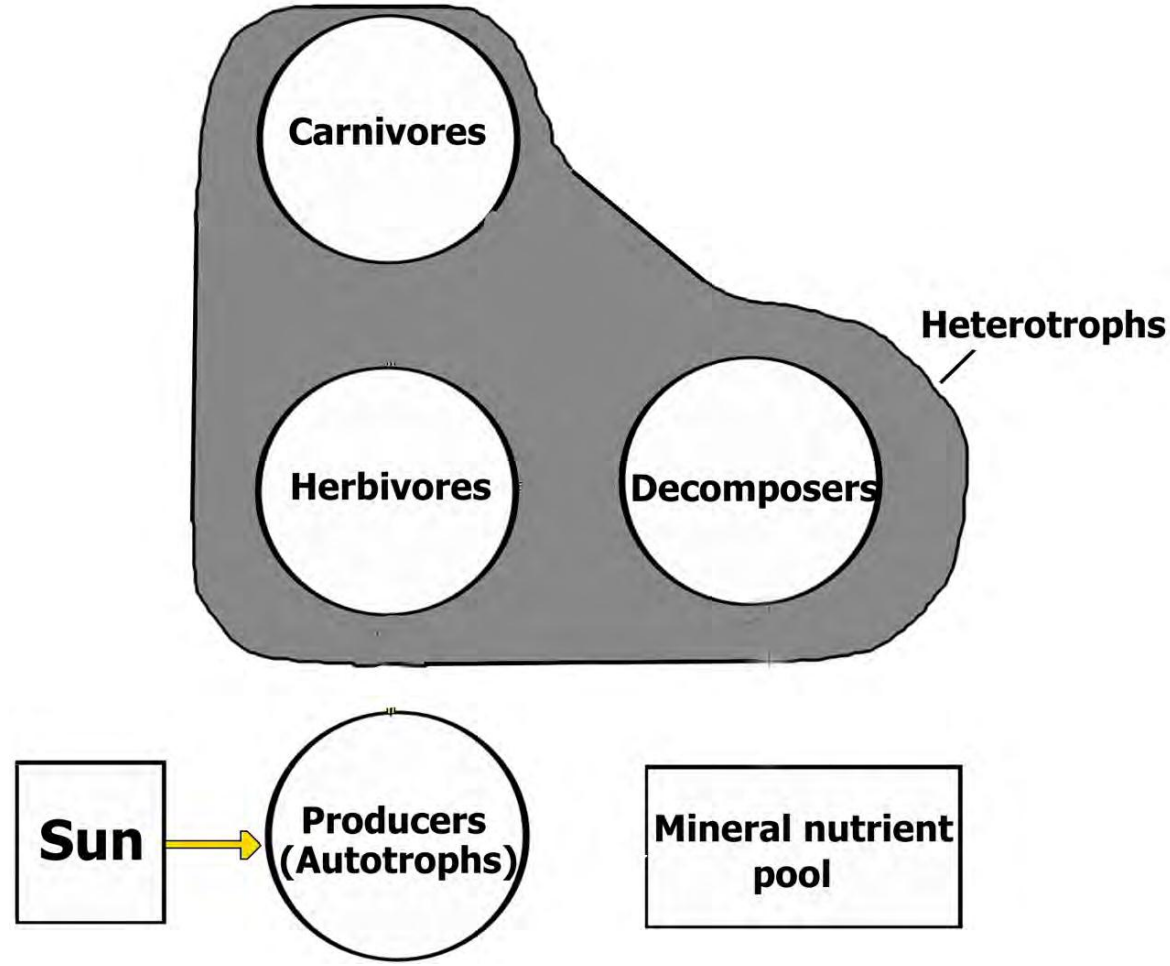


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Food web matter and energy cycling

In a simplified food web with a three trophic food chain (producers-herbivores-carnivores) linked to decomposers, the movement of mineral nutrients is cyclic, whereas the movement of energy is unidirectional and noncyclic.

Trophic species can be circled as nodes and arrows depicted the links.



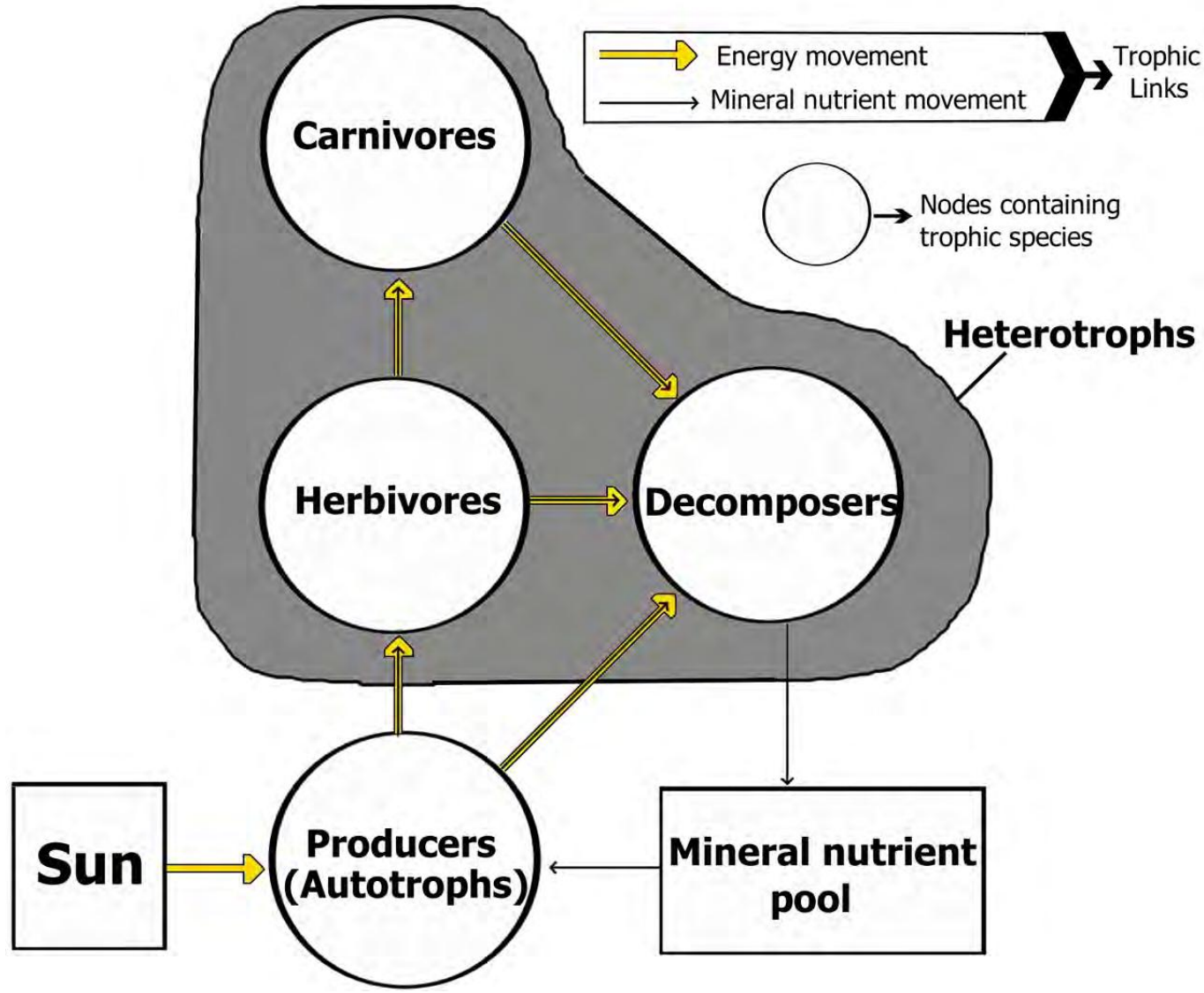
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Biogeochemical cycles

In a simplified food web with a three trophic food chain (producers- herbivores- carnivores) linked to decomposers, the movement of mineral nutrients is cyclical, whereas the movement of energy is unidirectional and non-cyclical.

Trophic species can be circled as nodes and arrows depicted the links.

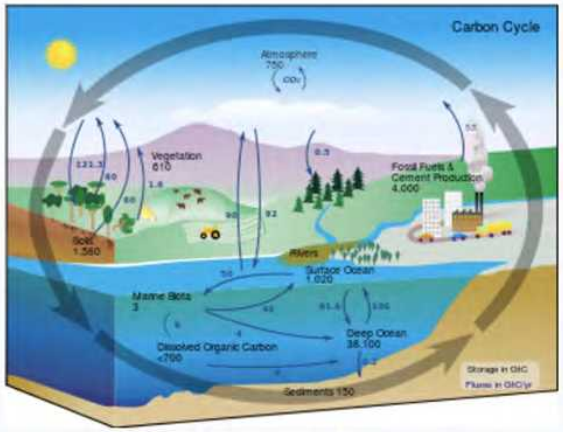


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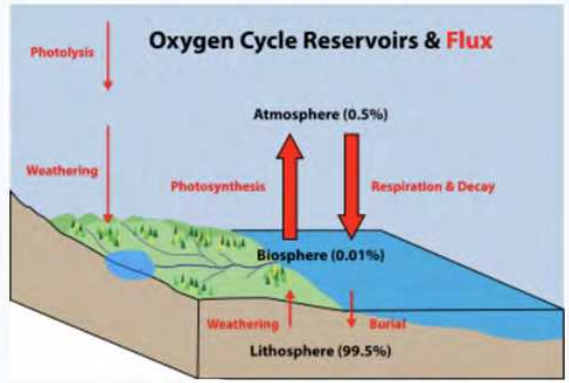
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In the Oceanography unit

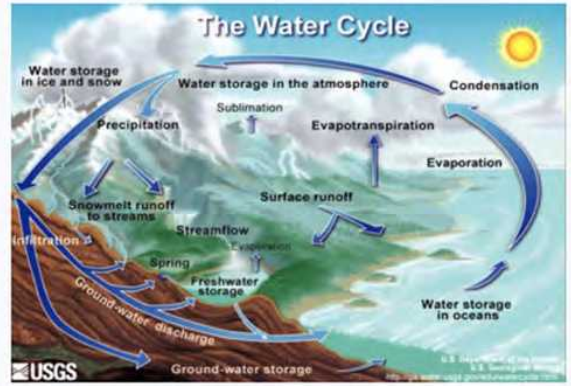
You studied the carbon, oxygen and water cycles.



Carbon cycle



Oxygen cycle

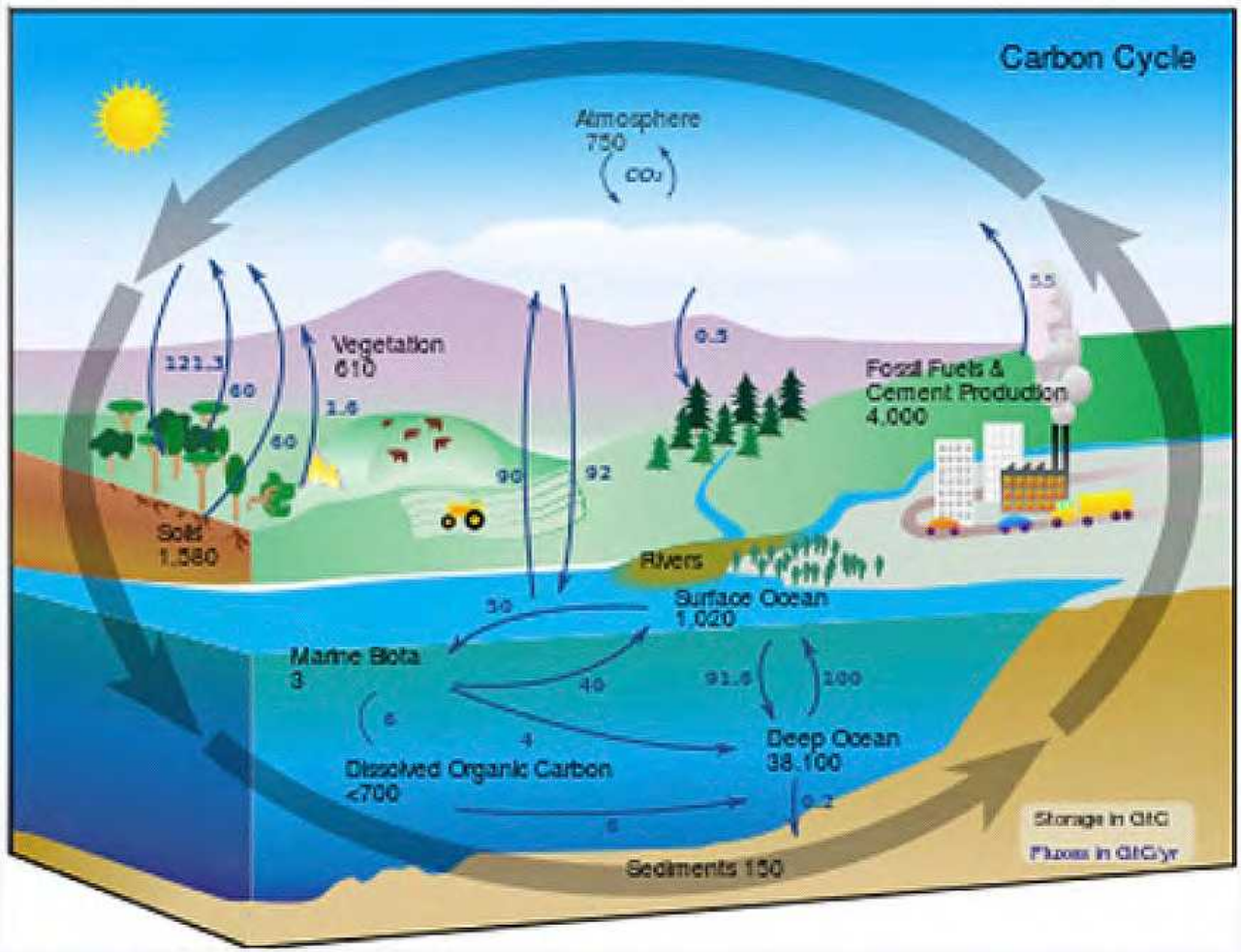


Water cycle

Carbon, oxygen and water cycles

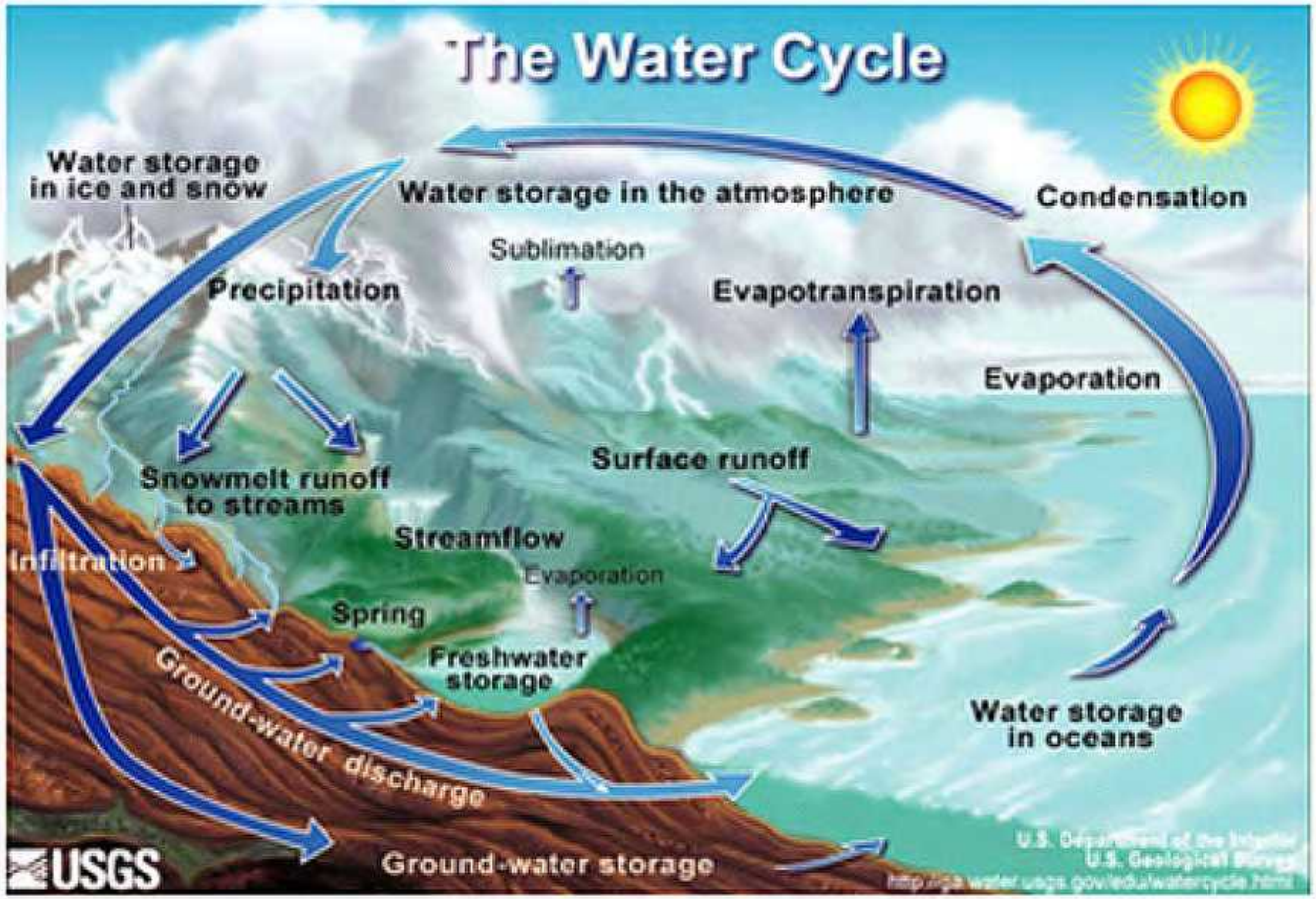
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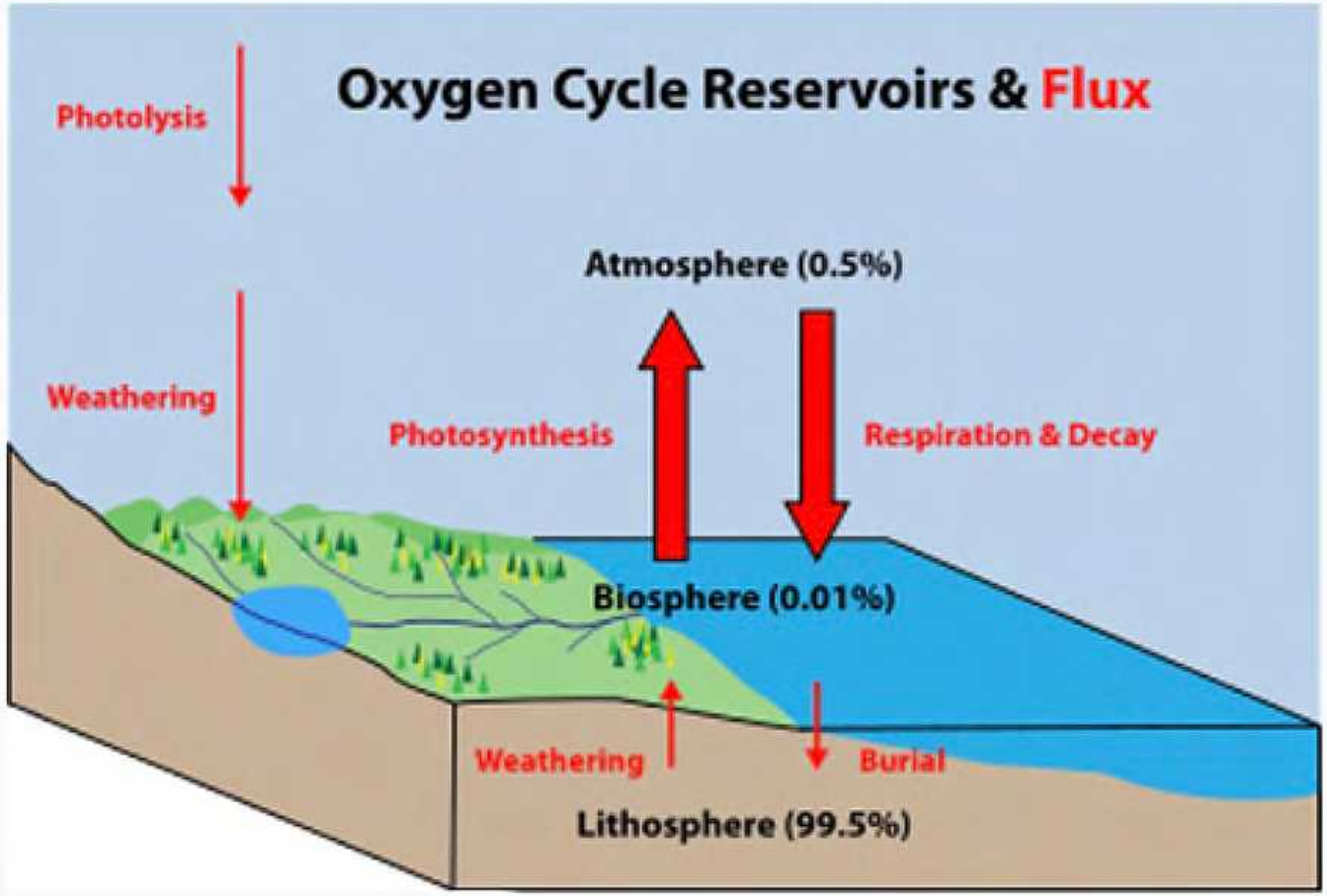
Carbon cycle

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Water cycle

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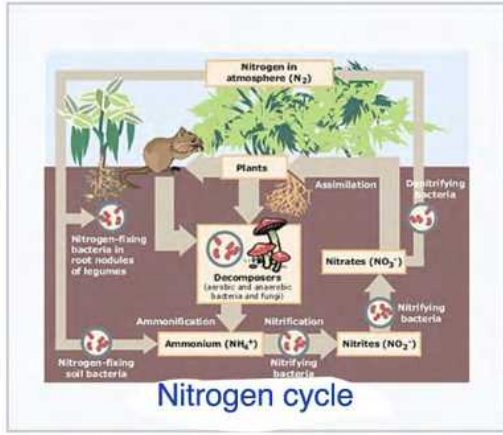


Oxygen cycle

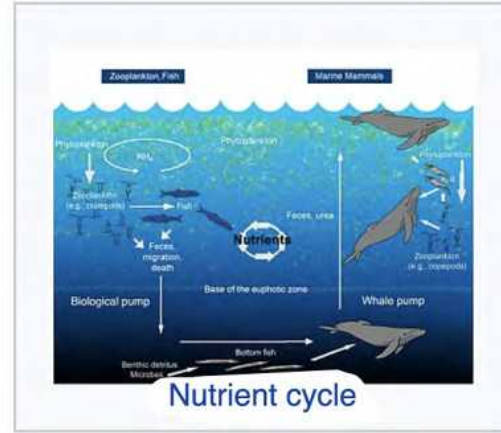
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Two other cycles that cycle matter in our estuarine ecosystem are the nitrogen and phosphorus cycles.

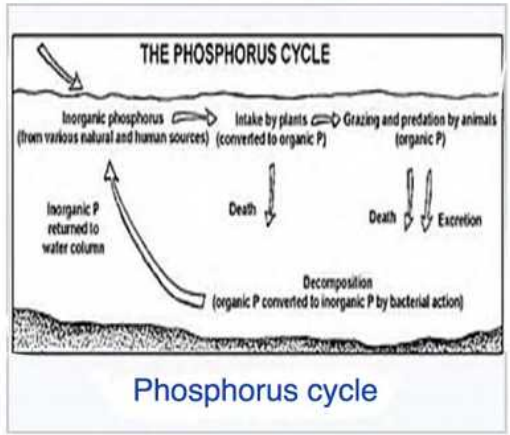
Note that there are others.



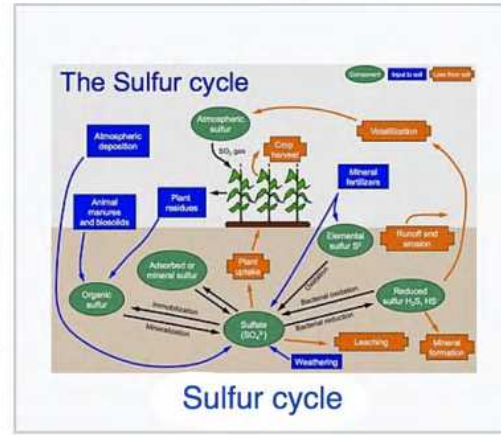
Nitrogen cycle



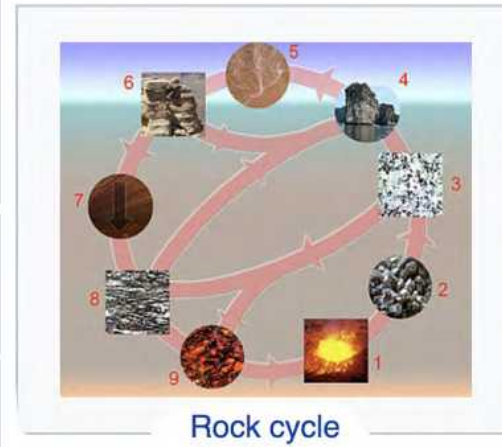
Nutrient cycle



Phosphorus cycle



Sulfur cycle



Rock cycle

Other cycles

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Sulphur - Welcome1To1The1Jungle at English Wikipedia [CC BY 3.0 (http://creativecommons.org/licenses/by/3.0)], via Wikimedia Commons
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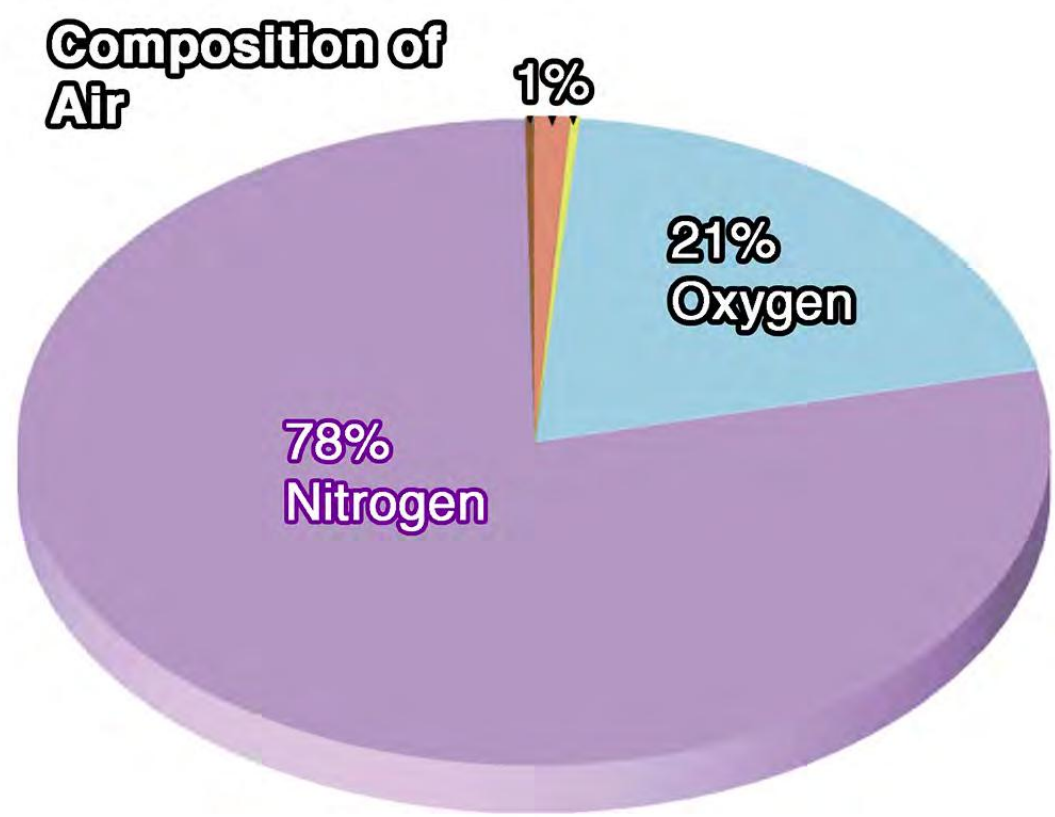
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Nitrogen cycle

Living organisms require nitrogen to build proteins.

Life cannot exist without nitrogen or its products.

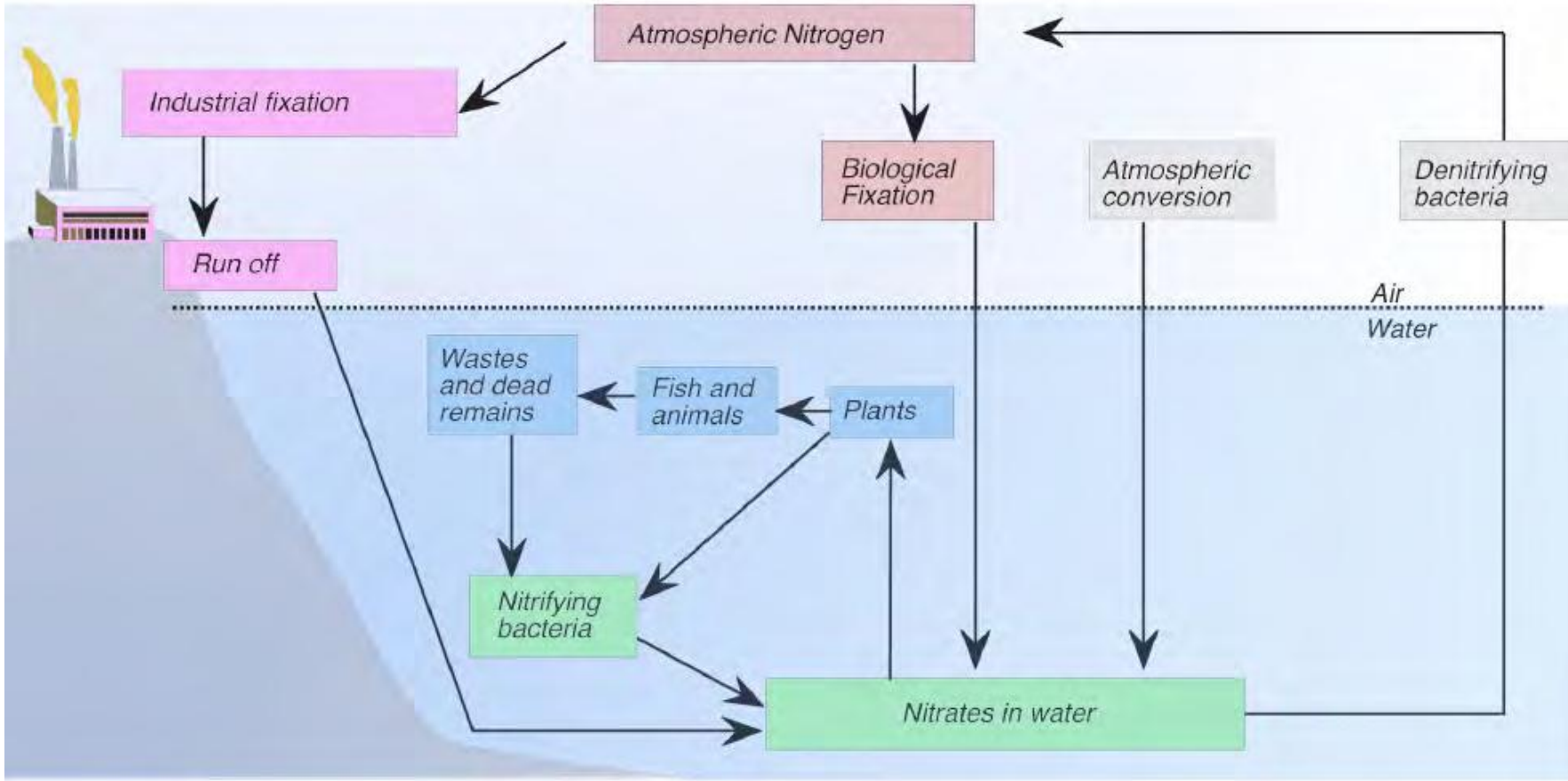
There is ample nitrogen for all organisms in the atmosphere (78% of the air is nitrogen gas), but most organisms cannot absorb nitrogen in this form.



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Nitrogen is taken up by plants in the form of nitrates (nitrogen compounds). The nitrogen is then passed along the food chain and then released back to the atmosphere by denitrifying bacteria.



Nitrogen cycle

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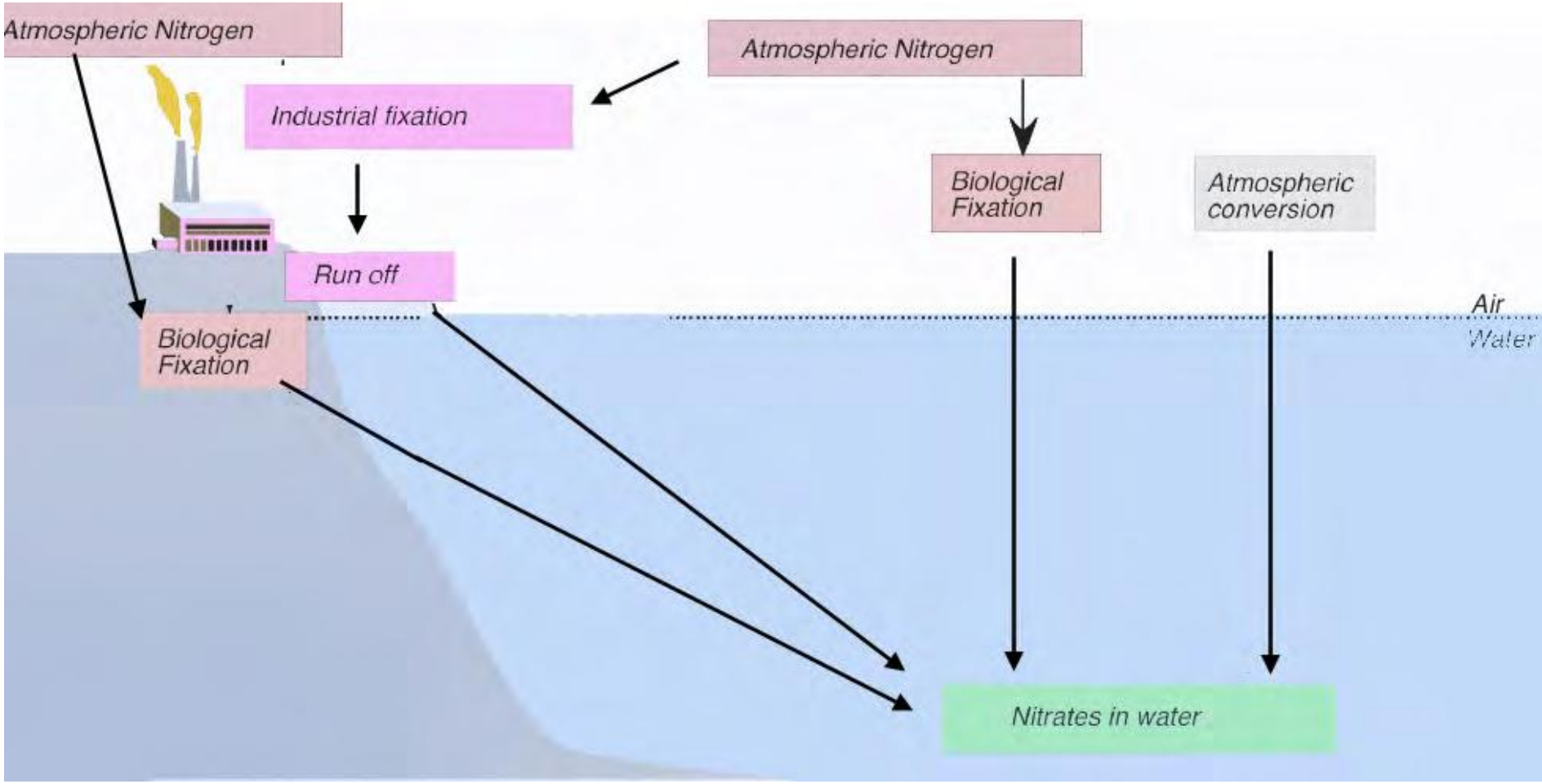
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Nitrogen is converted into nitrates in one of three ways.

a. Biological

b. Atmospheric fixation

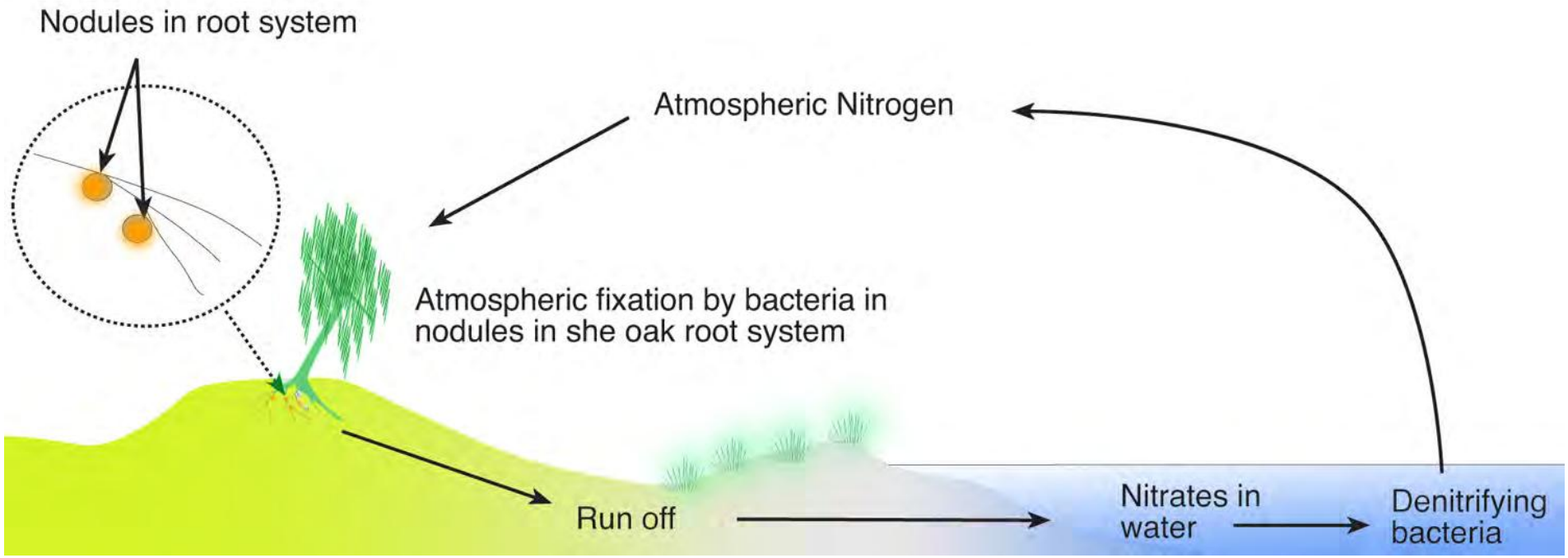
c. Industrial fixation



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Biological fixation

Some bacteria are able to convert atmospheric nitrogen gas into nitrates (NO_3). These are called nitrogen-fixing bacteria. These bacteria can be found living in soil, or floating in water. Others live in the nodules on the roots of plants, such as beans and clover. Blue green algae found in the oceans can also carry out this process.



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Atmospheric fixation

The high temperatures generated in lightning flashes combine atmospheric nitrogen gas with oxygen gas. The compounds produced are dissolved in the rain and washed into the soil and waterways.



By Mircea Madau - Edited version of Image:Lightning over Oradea Romania 2.jpg., Public Domain, https://commons.wikimedia.org/w/index.php?curid=5322846

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Industrial fixation

Factories manufacture artificial nitrogen fertilizers. These factories combine nitrogen and hydrogen gases at high temperatures and pressures to form ammonia (NH_4). These molecules are absorbed by the plants and phytoplankton of the oceans and converted into protein compounds.

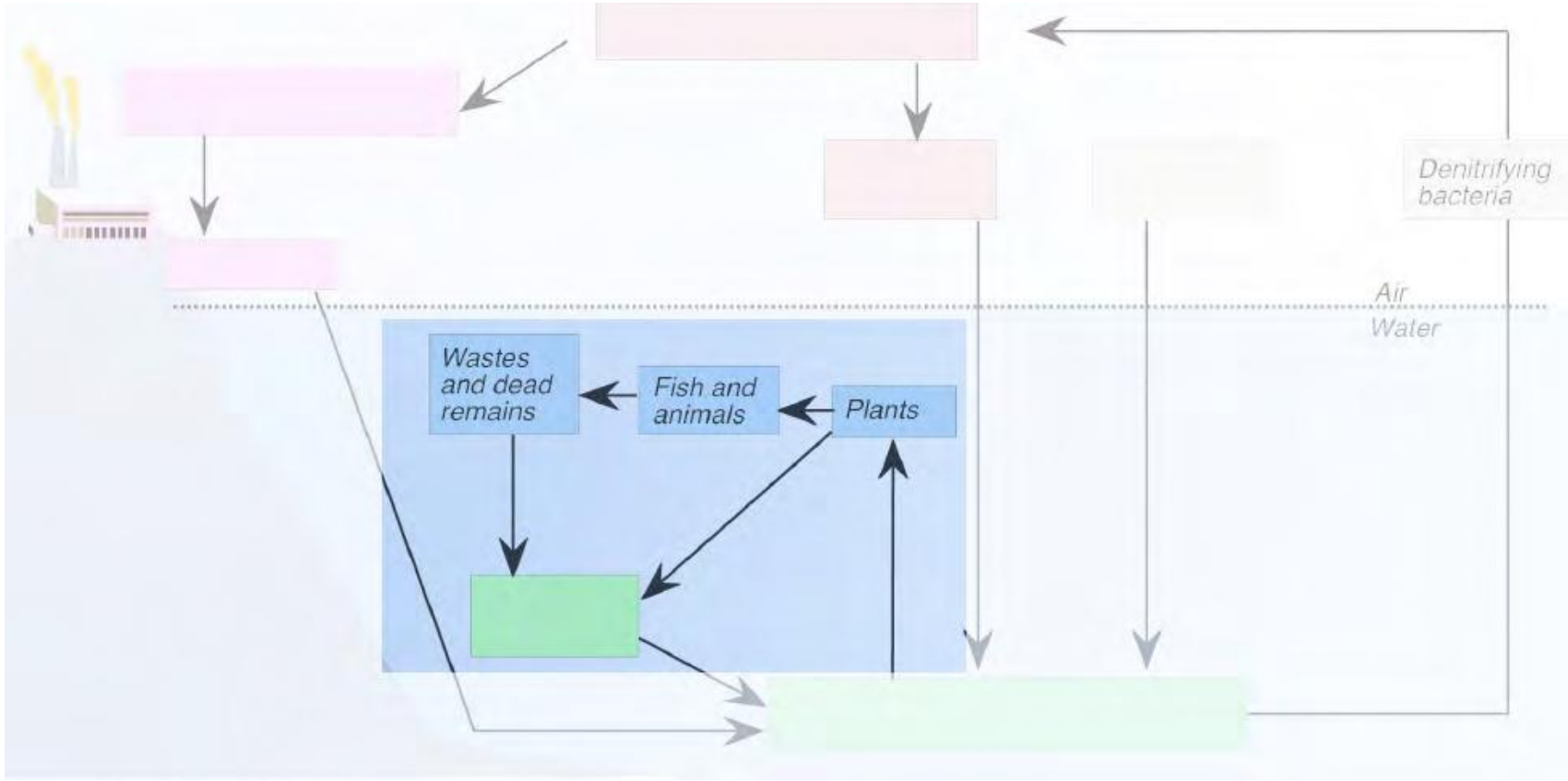


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These nitrates are absorbed by the plants and phytoplankton of the oceans and converted into protein compounds.

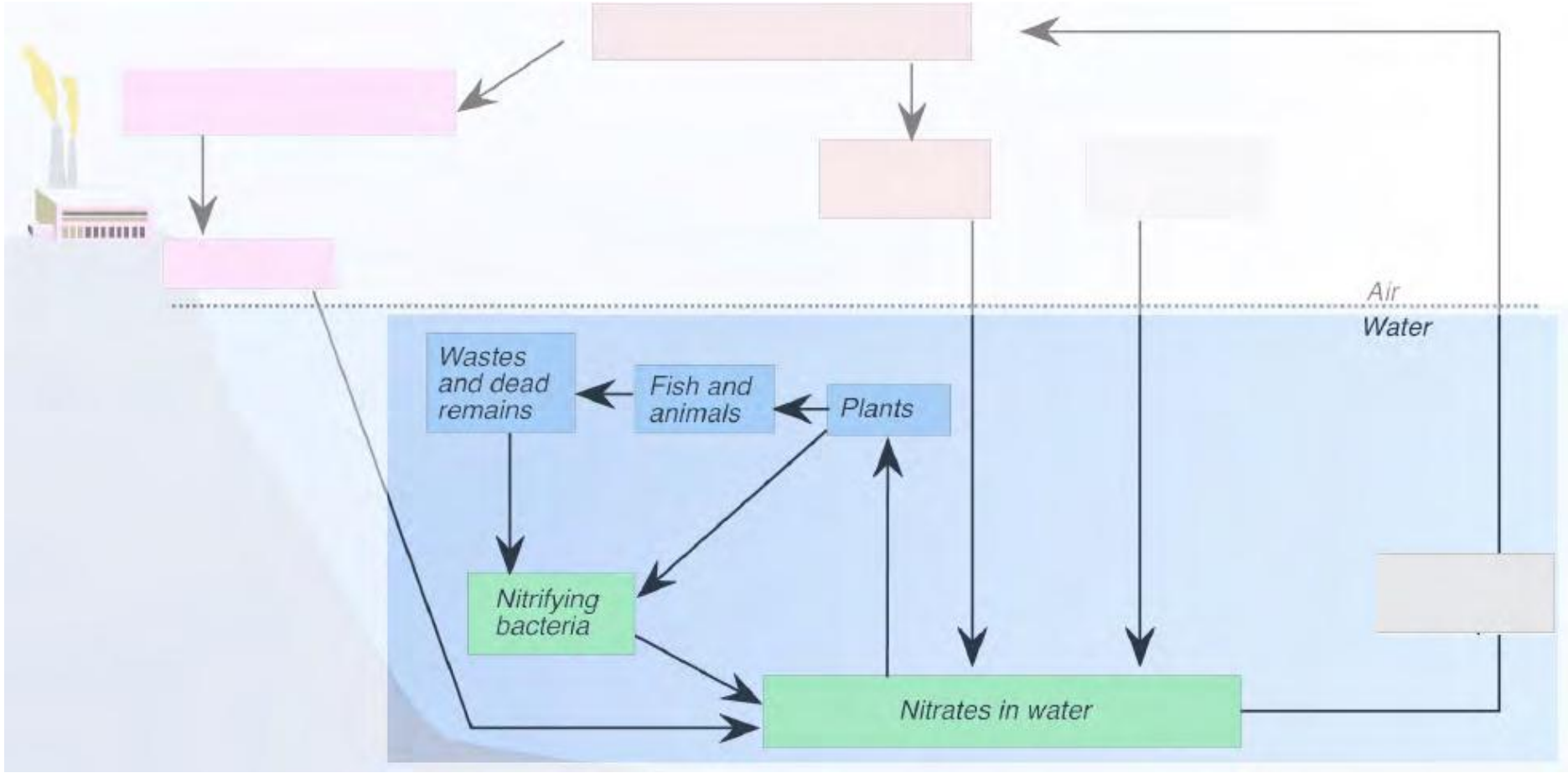
Fish and other marine animals then consume these proteins.



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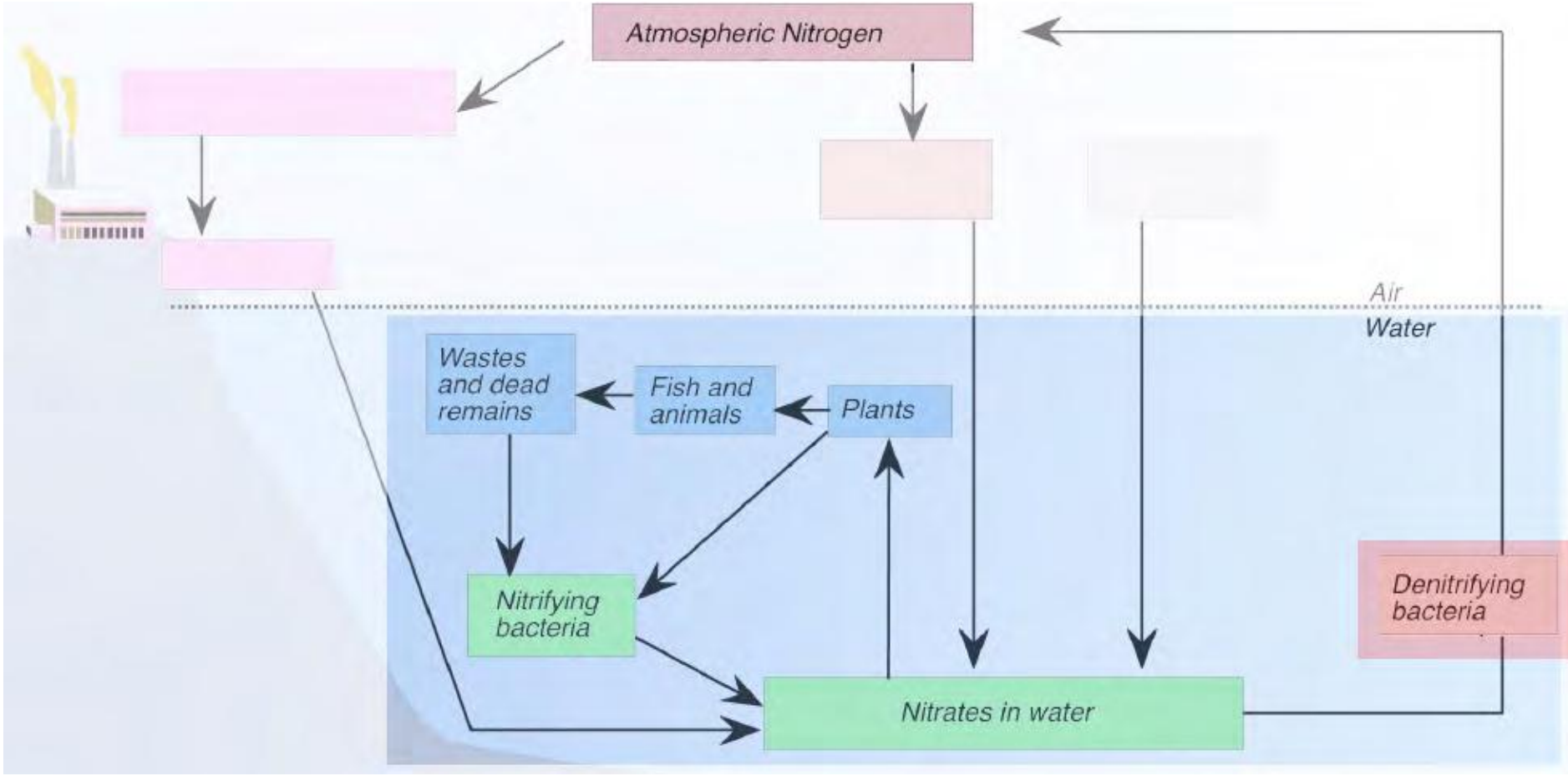
The decomposing bacteria eventually recycle the nitrates. The bacteria that convert the dead bodies and the wastes of the animals into nitrates are called nitrifying bacteria.



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Denitrifying bacteria convert these nitrates into nitrogen and oxygen gases, thus completing the cycle.



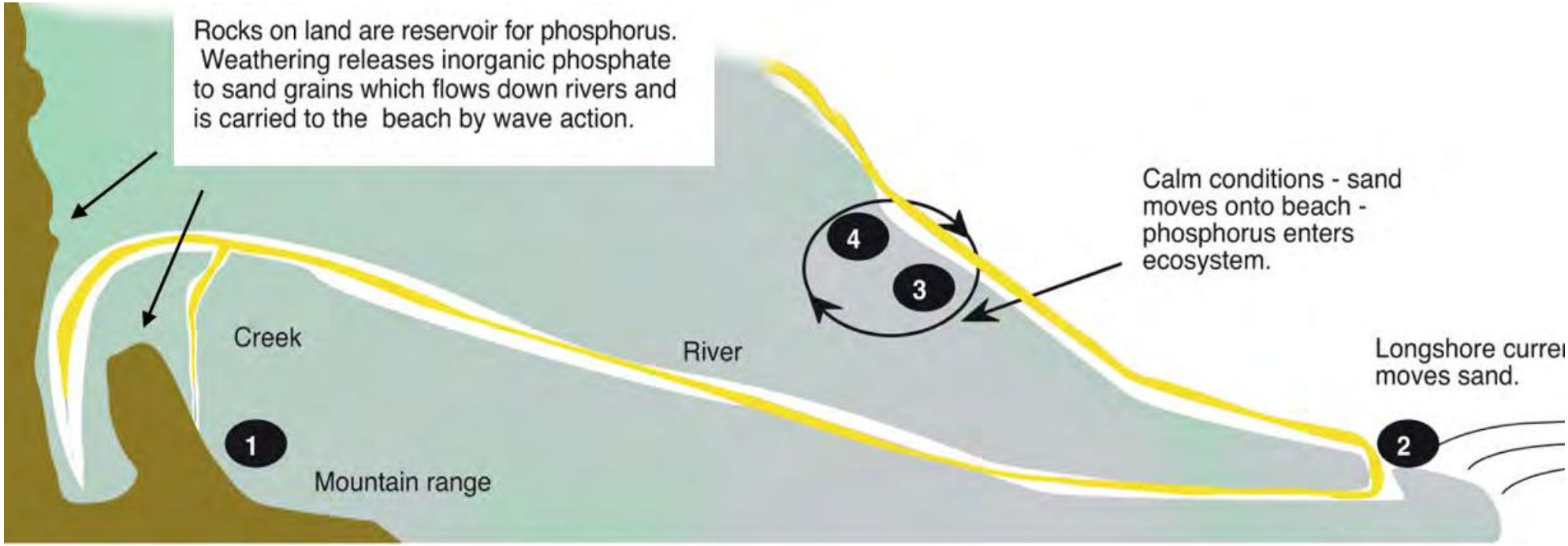
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Phosphorus cycle

Phosphorus is another important element for dune plants which have active root systems to seek out this element.

When quartz and feldspar are formed, they contain a fine coating of phosphorus which sticks to the sand grain as it moves along the coast.



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When the sand grains are washed up on the beach, they dry and are blown towards the dune plants.



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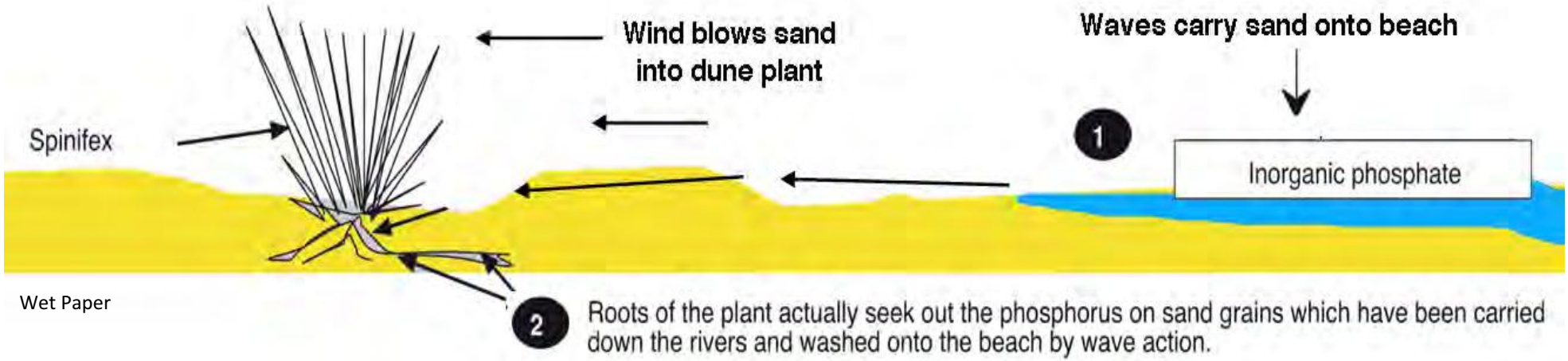
The broad leaf of the plant catches the grain by reducing the wind velocity and the grains falls to the base of the plant.



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Fine root hairs that grow from the main plant, then absorb the phosphorus coating from the sand grain, providing vital nutrients for the plant to grow.



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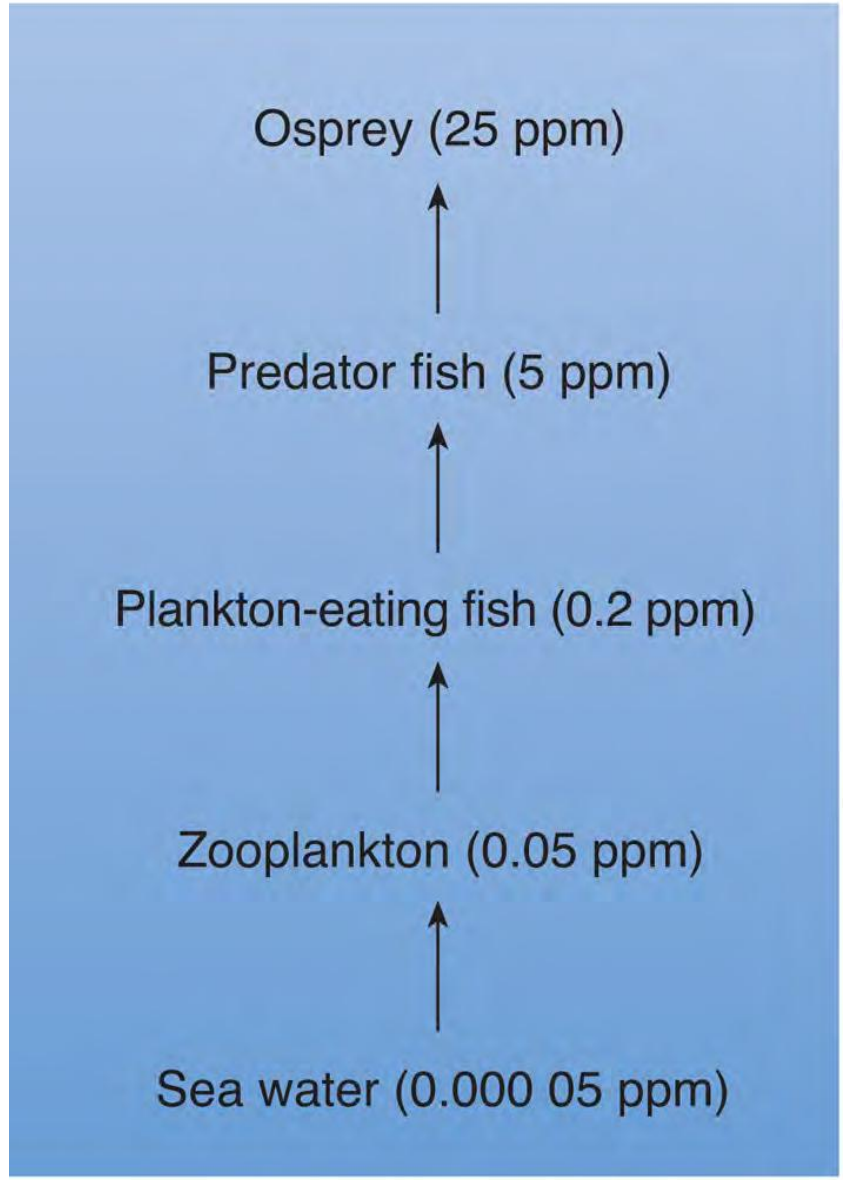
Bioaccumulation

Many chemicals in the environment are said to be cumulative.

Cumulative chemicals build up within the body and in most cases the body cannot rid itself of these chemicals.

DDT, (an insecticide) was a classic bioaccumulator of a pollutant that caused the egg shells of marine birds to become brittle.

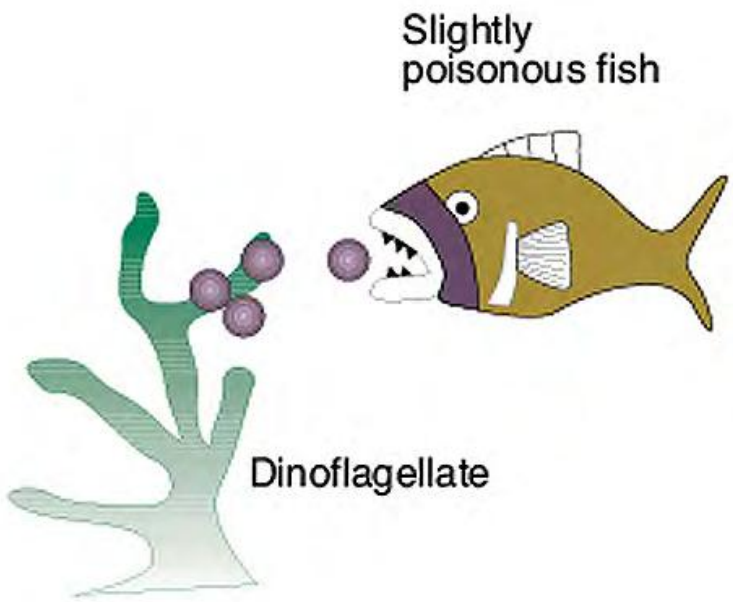
This resulted in a decrease of apex predators in some parts of the world.



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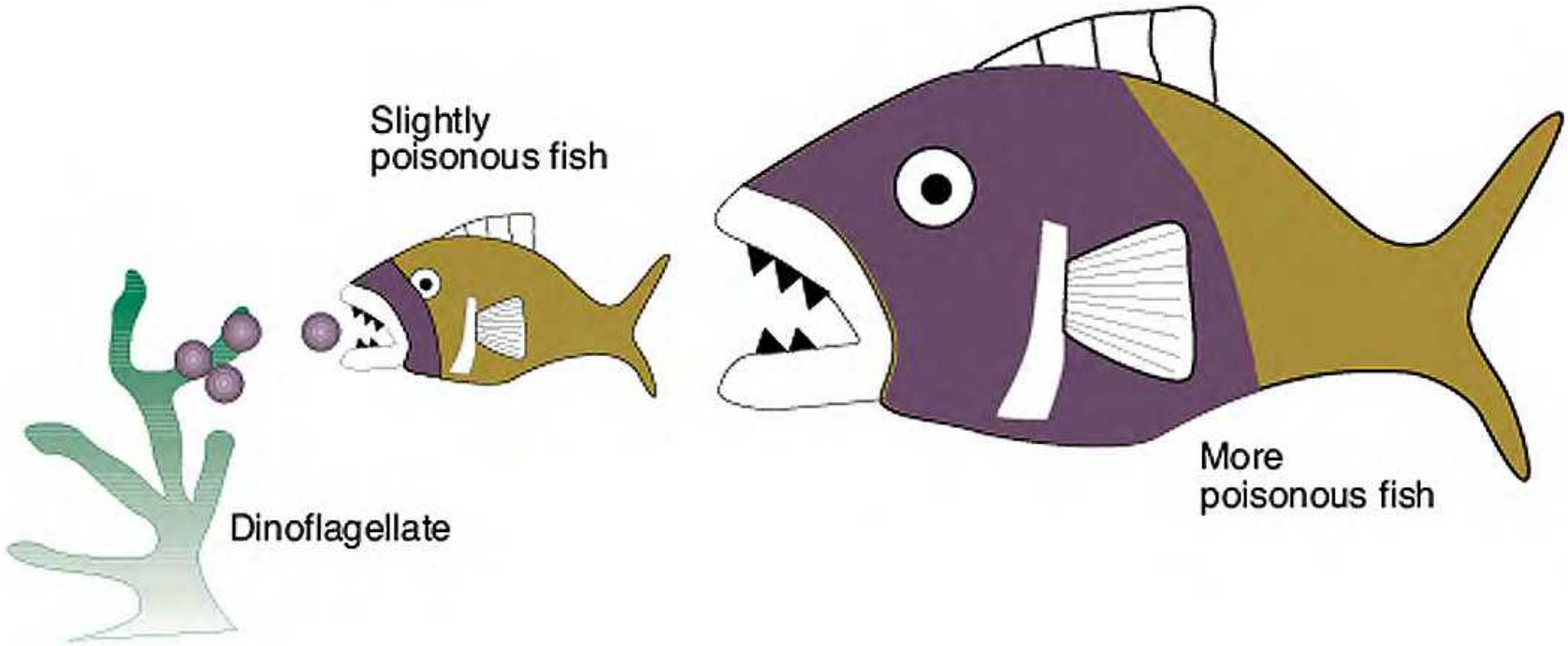
When a consumer organism eats an organism that contains cumulative chemicals such as the toxin ciguatera from eating dinoflagellates, the amount of chemical found in the prey can be absorbed.



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Resulting in a poisonous fish



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Ciguatera fish poisoning, also known simply as ciguatera, is a foodborne illness caused by eating reef fish whose flesh is contaminated with certain toxins.

It results from ciguatoxin bioaccumulating in reef fish.

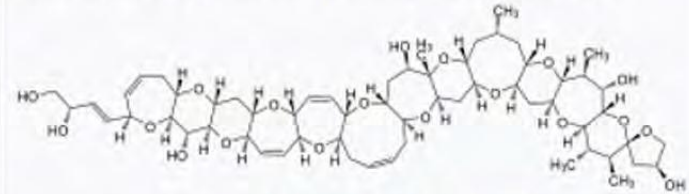
Reference

https://en.wikipedia.org/wiki/Ciguatera_fish_poisoning

Ciguatoxin aka CTX1B, a neurotoxin isolated from the marine dinoflagellate Gambierdiscus toxicus.
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Ciguatera fish poisoning

Synonyms	Ciguatera, ciguatera food poisoning



Chemical structure of ciguatoxin

Symptoms	Diarrhea, vomiting, numbness, itchiness, sensitivity to hot and cold, dizziness, weakness[1][2]
Usual onset	30 min to 2 days[3]
Duration	Few weeks to months[3]
Causes	Ciguatoxin and maitotoxin within certain reef fish[2]
Risk factors	Barracuda, grouper, moray eel, amberjack, sea bass, sturgeon.[2]
Diagnostic method	Based on symptoms and recently eating fish[1]
Differential diagnosis	Paralytic shellfish poisoning, neurotoxic shellfish poisoning, scombroid food poisoning, pufferfish poisoning[1]
Treatment	Mannitol, gabapentin, amitriptyline[1][2]
Prognosis	Risk of death < 0.1%[2]
Frequency	~50,000 per year[2]

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Summary

- Nutrients are crucial to the growth of organisms.
- Decomposers break down dead organisms into nutrients and gases so that they can be used by other organisms.
- Nutrients can enter or exit an ecosystem at any point and can cycle around the planet.

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Further study

The sulphur cycle

•Oceans are a rich source of sulphur with large amounts being found in the sediments at the bottom.
•Sulphur is needed by most organisms to build proteins.
•Plants and phytoplankton take in the sulphur in the form of sulphate ions.
•This sulphur is then passed along the food chain.
•Dead organisms and wastes are finally converted back into sulphate ions by bacteria.
•Some anaerobic bacteria convert hydrogen sulphide, a poisonous smelly gaseous pollutant into useful proteins.



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- Sulphur is building up in the atmosphere because of the burning of fossil fuels that contain sulphur.
- This turns into sulphur dioxide (SO_2) which is a particular problem.
- This gas combines with rain to form sulphuric acid, with the new mixture now called **"acid rain".**
- This **acid rain** can severely damage buildings, unprotected metals and cause the acidity of lakes and waterways to increase.
- This acidic water can dissolve many metal elements and these will be consumed in the drinking of this water.
- The sulphur cycle is not a balanced cycle.

VIDEO reference

http://www.bozemanscience.com/biogeochemical-cycling

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Question

Write a description of how matter cycles in a food web and describe how the addition of a toxin such as ciguateria from a dinoflagellate, bioaccumulates in the food chain.

Use the phosphorus and nitrogen cycles to illustrate your answer.



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Questions

1.Describe how matter cycles through an estuarine food web.

2.Describe how the introduction of a toxin could cause bioaccumulation in the food chain.



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T049 Population terms



Bob Moffatt

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Syllabus statement

At the end of this topic you should be able to ...

Recall

the terms population size, density, abundance, distribution (i.e. clumped, uniform, random), carrying capacity, niche, K-strategists and r-strategists, keystone species





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Recall

remember; present remembered ideas, facts or experiences; bring something back into thought, attention or into one's mind

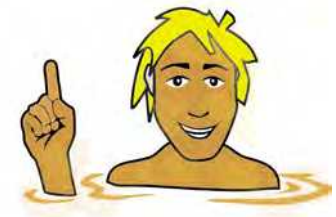


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Objective

To write the definitions and give examples for the following population terms:

- Population size
- Population density
- Population abundance
- Population distribution - clumped, uniform, random
- Carrying capacity
- Niche
- K and r strategists
- Keystone species



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Population definition

A group of organisms of one species that interbreed and live in the same place at the same time (e.g. spoonbill population).



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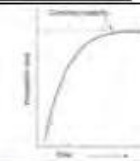
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Question

Write the definition for the following population terms by completing the following table.

Population term	Definition	Example / explanation
Population size		
Population density		
Population abundance		
Population distribution		
Clumped		
Uniform		
Randon		
Carrying capacity		
Niche		
r and K strategists		
Keystone species		

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Population term	Definition	Example / explanation
Population size	The actual number of individuals in a population.	If we were to study a rocky shore there might be 2,000,000 barnacles on the particular rocky headland.
Population density	A measurement of population size per unit area, i.e., population size divided by total land area.	Scientists expressing a density of plankton in an area may give the population density as the number of plankton per litre or 100 cm2. The amount of seagrass found in an area may be expressed as the number of plants per square metre.
Population abundance	The relative representation of a species in a particular ecosystem.	The ACFOR scale is commonly used with A – for "Abundant", C – for "Common", F – for "Frequent", O – for "Occasional" and R – for "Rare" within the given area.
Population distribution		
Clumped	The distance between neighbouring individuals is minimized.	
Uniform	The distance between neighbouring individuals evenly spaced.	
Random	The position of each individual is independent of the other individuals	
Carrying capacity	The maximum population size of the species that the environment can sustain indefinitely, given the food, habitat, water, and other necessities available in the environment.	To find carrying capacity on a graph, you locate the point on the graph where the population line is horizontal. 
Niche	An ecological niche is the role and position a species has in its environment; how it meets its needs for food and shelter, how it survives, and how it reproduces.	A species' niche includes all of its interactions with the biotic and abiotic factors of its environment. Archer Fish spitting at flying insects, using the air above water as a ecological niche. The Archer fish is using the ecological niche of the " air above water " and has adapted to this niche by being able to spit water at flying insects.

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r and K strategists	r/K selection theory relates to the selection of combinations of traits in an organism that trade off between quantity and quality of offspring.	Whale reproduction follows a K-selection strategy, with few offspring, long gestation, long parental care, and a long period until sexual maturity. Corals and mass spawning worms are a good example of a r selected species because they emphasize high growth rates, typically exploit less-crowded ecological niches, and produce many offspring, each of which has a relatively low probability of surviving to adulthood (i.e., high r, low K).
Keystone species	A keystone species is a species having a disproportionate effect on the ecosystem.	A classic keystone species is a predator that prevents a particular herbivorous species from eliminating dominant plant species. If prey numbers are low, keystone predators can be even less abundant and still be effective. Yet without the predators, the herbivorous prey would explode in numbers, wipe out the dominant plants, and dramatically alter the character of the ecosystem. For example sharks are a keystone species. Other examples are corals, seagrasses and mangroves because thy create habitat.

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Population size

The actual number of individuals in a population.



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Example

If we were to study a rocky shore there might be 2,000,000 barnacles on the particular rocky headland.



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Population density

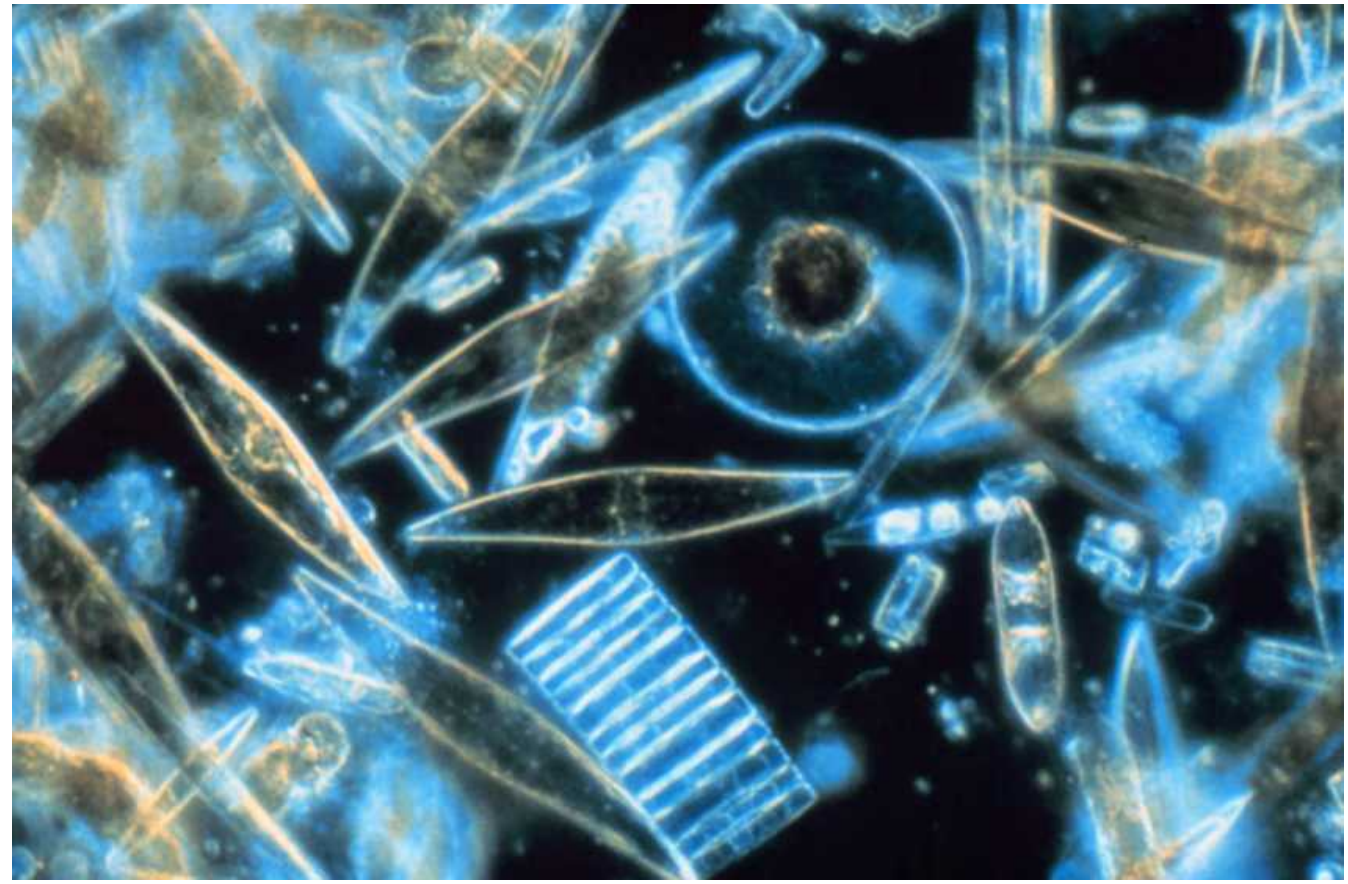
A measurement of population size per unit area,
i.e., population size divided by total land area.



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or

Scientists expressing a density of plankton in an area may give the population density as the number of plankton per litre or 100 cm^2.



Assorted diatoms as seen through a microscope.

By Prof. Gordon T. Taylor, Stony Brook University - corp2365, NOAA Corps Collection, Public Domain, https://commons.wikimedia.org/w/index.php?curid=246319

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The amount of seagrass found in an area may be expressed as the number of plants per square metre.

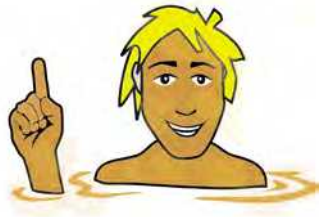


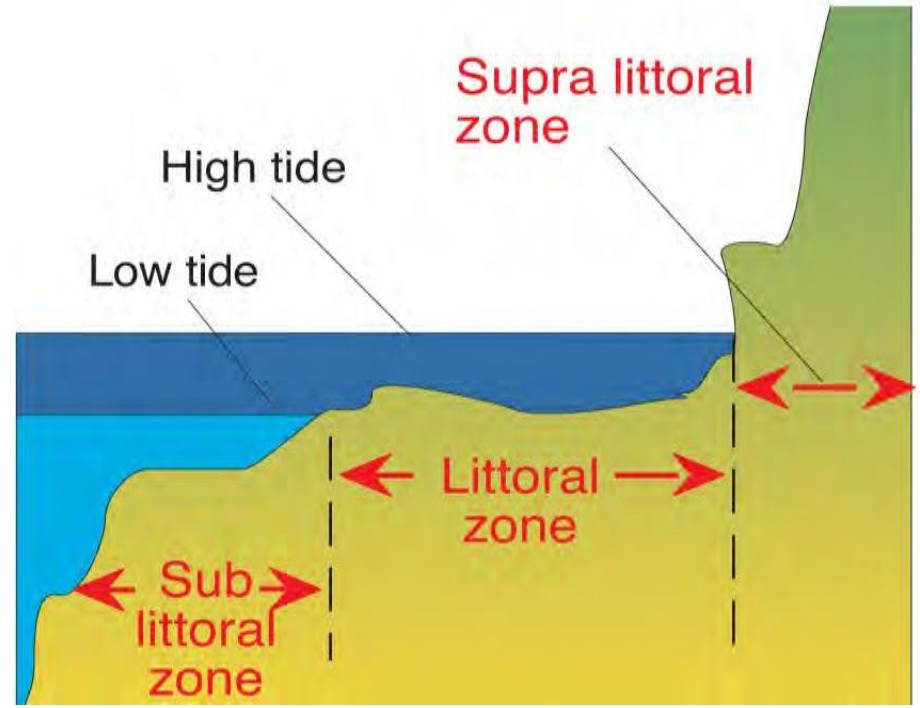
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Population abundance

The relative representation of a species in a particular ecosystem.





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Rocky shore platform



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Or a coral cay



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Example

The ACFOR scale is commonly used with A – for "Abundant", C – for "Common", F – for "Frequent", O – for "Occasional" and R – for "Rare" within the given area.

Sometimes

- Dominant
- Sub dominant
  Present
- Absent

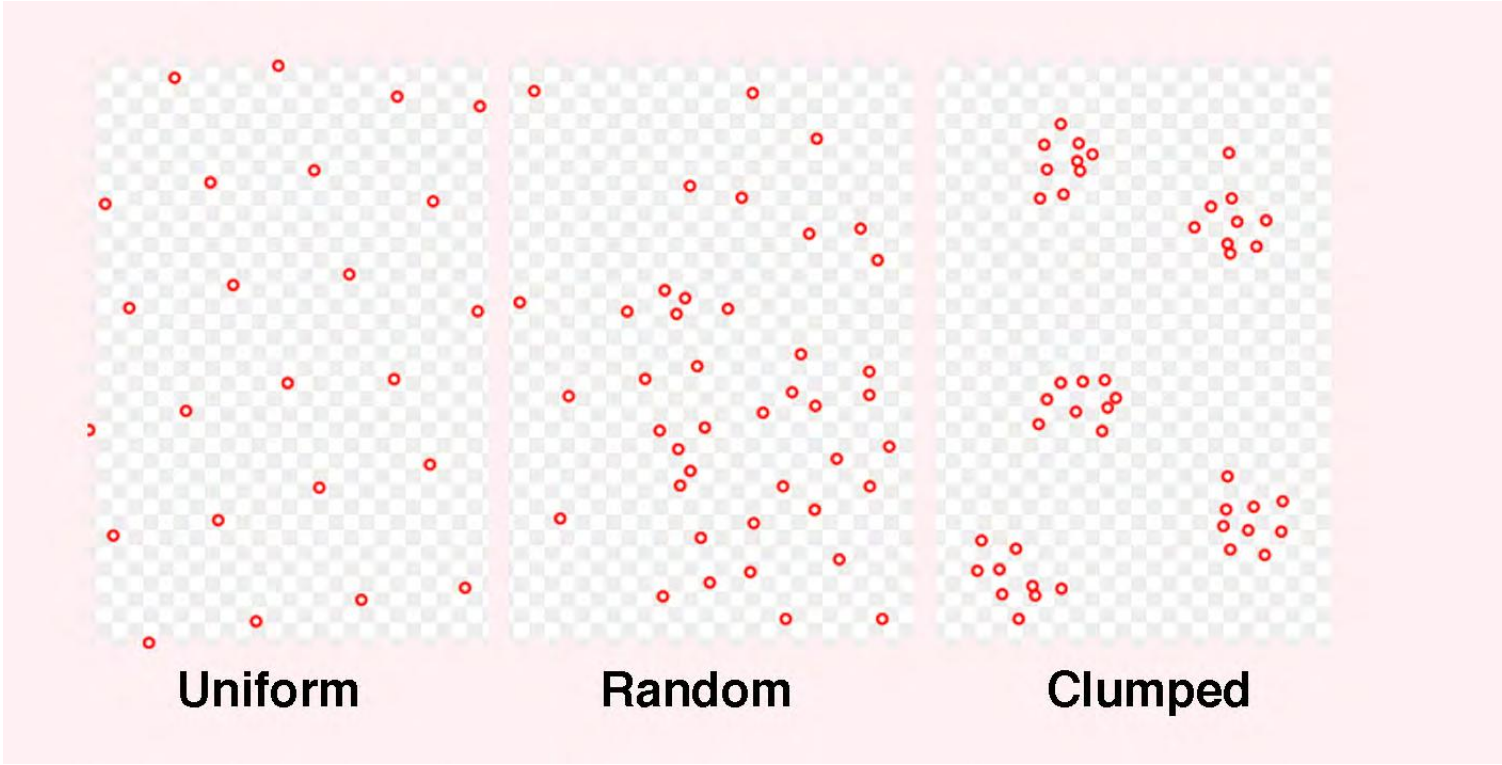
As this kite diagram of a rocky shore depicts.



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Population distribution

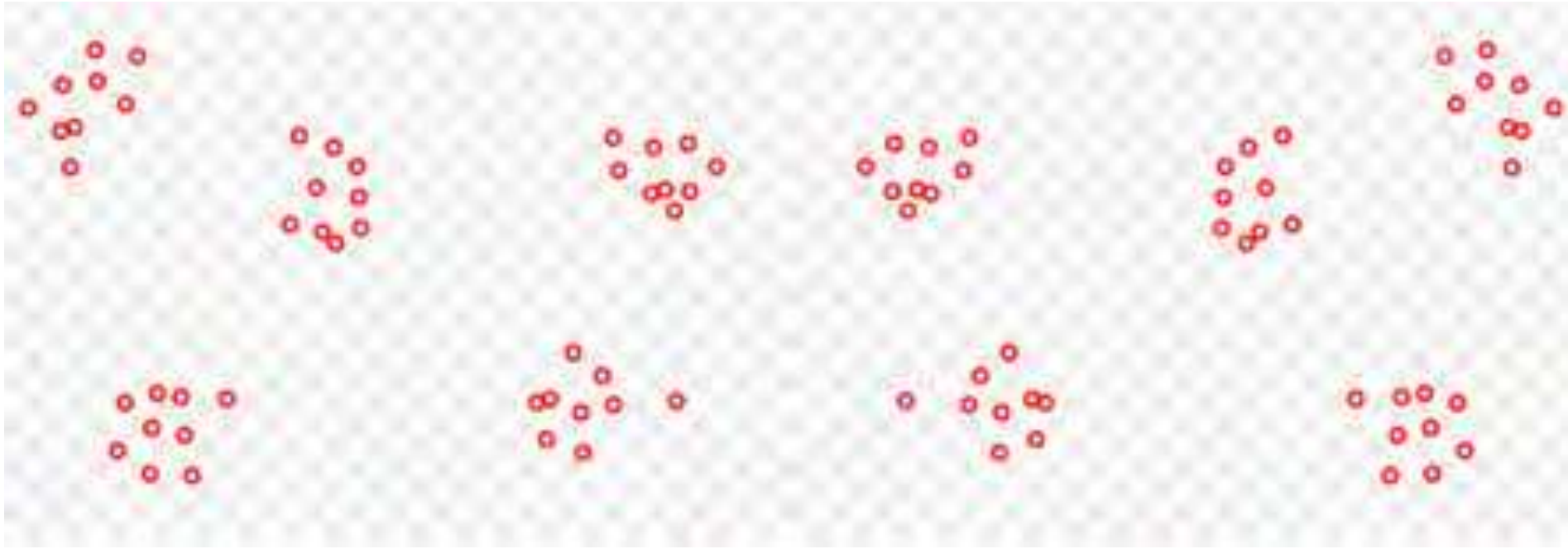


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Clumped

The distance between neighbouring individuals is minimized.



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Uniform

The distance between neighbouring individuals evenly spaced.

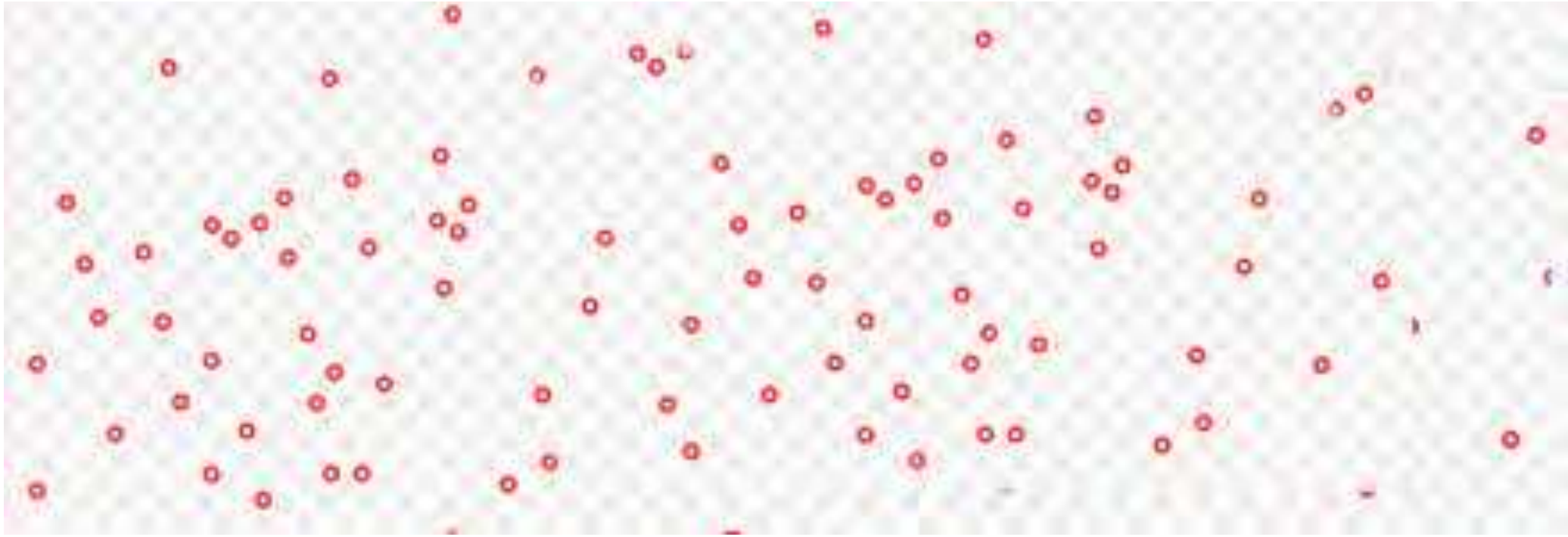


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Random

The position of each individual is independent of the other individuals.



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Carrying capacity

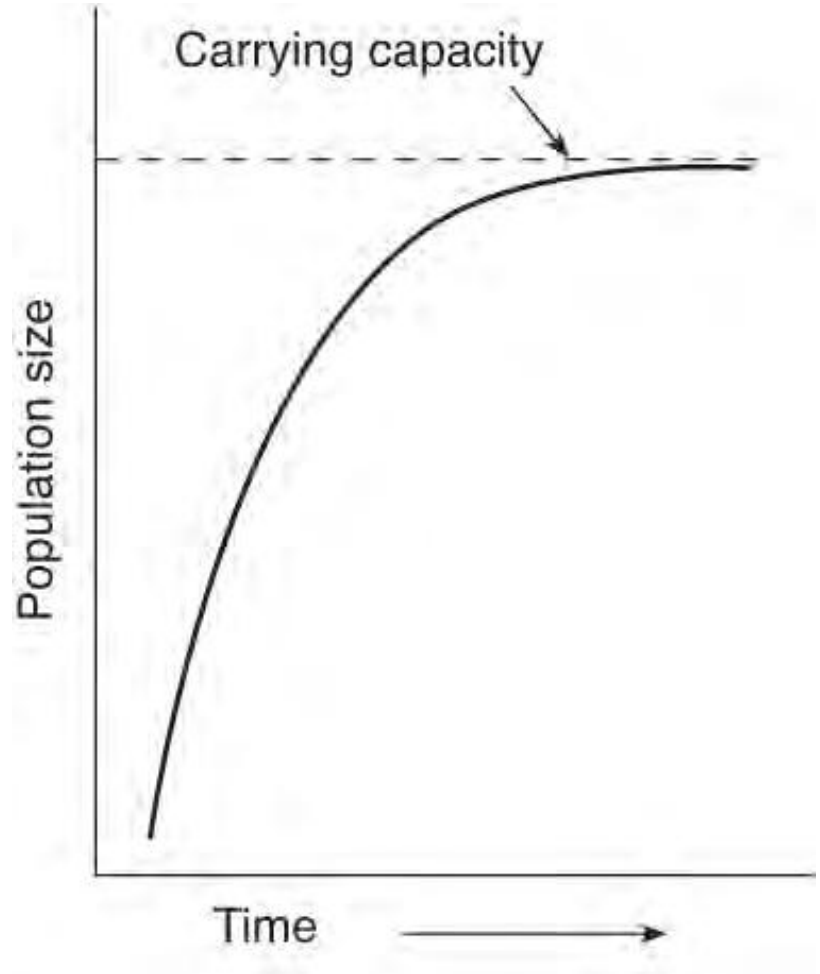
The maximum population size of the species that the environment can sustain indefinitely, given the food, habitat, water, and other necessities available in the environment.



By Image ID: corp2417, NOAA Corps CollectionPhotographer: Giuseppe ZibordiCredit: Michael Van Woert, NOAA NESDIS, ORA - From german wikipedia at http://de.wikipedia.org/wiki/Bild:Kaiserpinguine_mit_Jungen.jpg, Public Domain, https://commons.wikimedia.org/w/index.php?curid=748680

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To find carrying capacity on a graph, you locate the point on the graph where the population line is horizontal.



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Niche

An ecological niche is

- the role and position a species has in its environment
- how it meets its needs for food and shelter
- how it survives, and
- how it reproduces.



Sharryn Madder and Kerry Kitzelman

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Example

Archer Fish spitting at flying insects, using the air above water as an ecological niche.

The Archer fish is using the ecological niche of the " air above water " and has adapted to this niche by being able to spit water at flying insects.

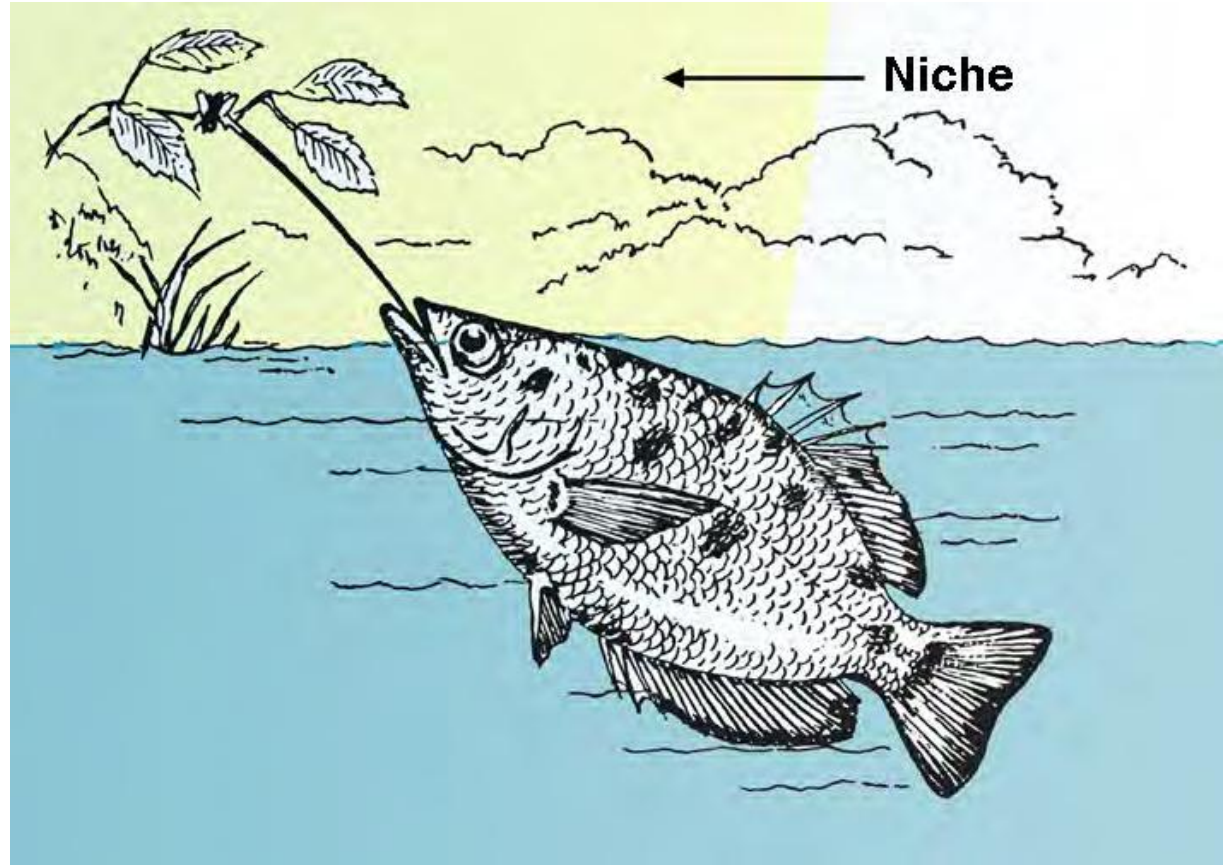


Illustration of an archerfish shooting water at a bug on a hanging branch
By Pearson Scott Foresman - Archives of Pearson Scott Foresman, donated to the Wikimedia FoundationThis file has been extracted from another file: PSF A-50002.png, Public Domain, https://commons.wikimedia.org/w/index.php?curid=3596173

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r and K strategists

r = ‘rate’ and K = ‘carrying capacity’

r/K selection theory relates to the selection of combinations of traits in an organism that trade off between quantity and quality of offspring.

r-selected species are those that produce many offspring with minimal parental rearing.

K-selected species are those that produce few offspring yet spend more time rearing.



Kerry Kitzelman

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Examples

Corals and mass spawning worms are a good example of a r selected species.

Because they emphasize high growth rates, typically exploit less-crowded ecological niches,

and

produce many offspring abandoning them to the currents, each of which has a relatively low probability of surviving to adulthood (i.e., high r, low K).

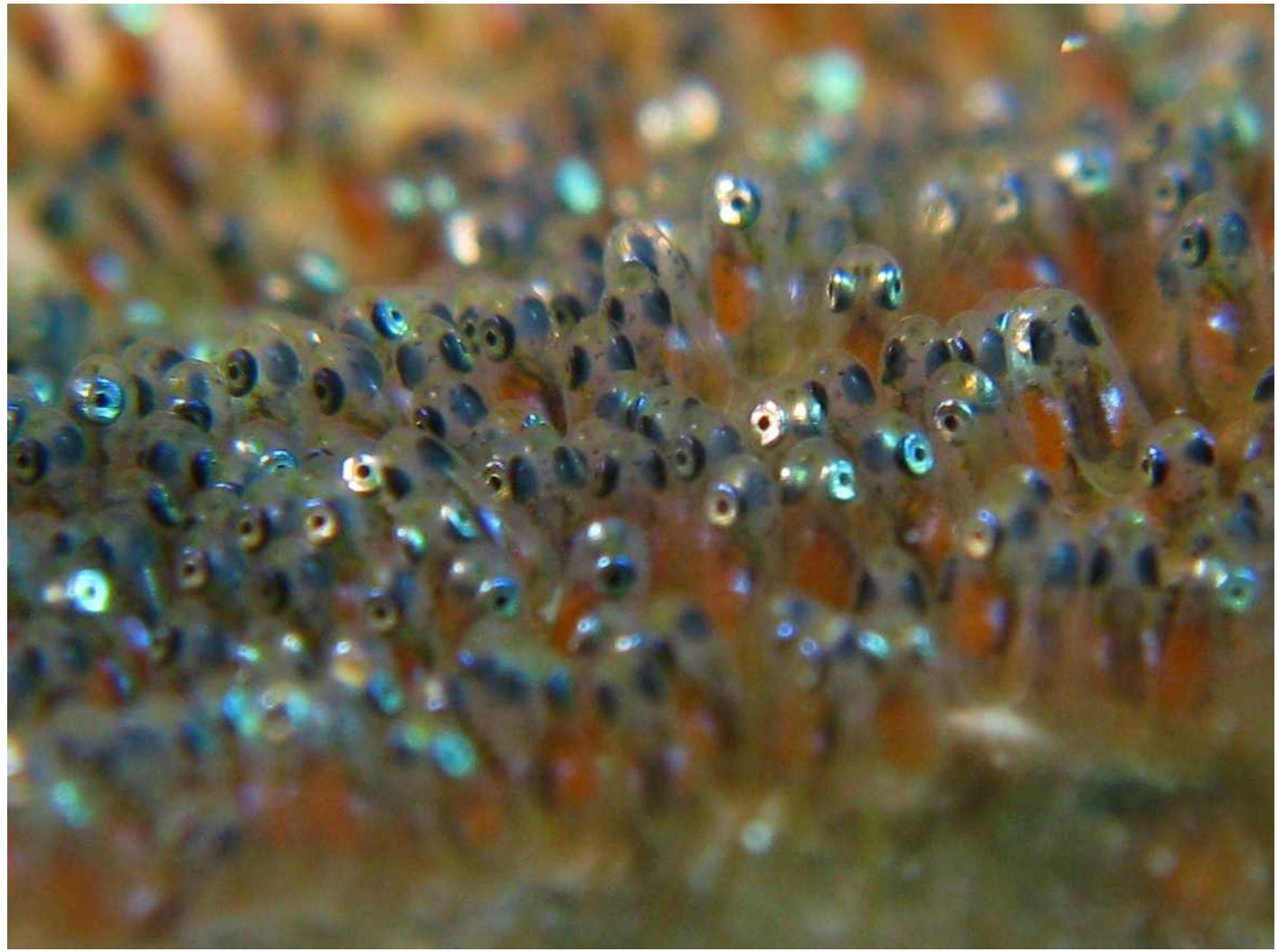


From Aimshttps://www.ausmarinescience.com/marine-science-basics/marine-biology/coral/

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The spawn (eggs) of a clownfish.

The black spots are the developing eyes



By Silke Baron - originally posted to Flickr as Anemone Fish spawn - Eggs or Babies?, CC BY 2.0, https://commons.wikimedia.org/w/index.php?curid=8267573

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Whales are examples of a K selected species.



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Humpback whale with her calf



By National Marine Sanctuaries - Whales, CC BY 2.0,
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Keystone species

A keystone species is a species having a disproportionate effect on the ecosystem.
A classic keystone species is a predator that prevents a particular herbivorous species from eliminating dominant plant species.

If prey numbers are low, keystone predators can be even less abundant and still be effective. Yet without the predators, the herbivorous prey would explode in numbers, wipe out the dominant plants, and dramatically alter the character of the ecosystem.



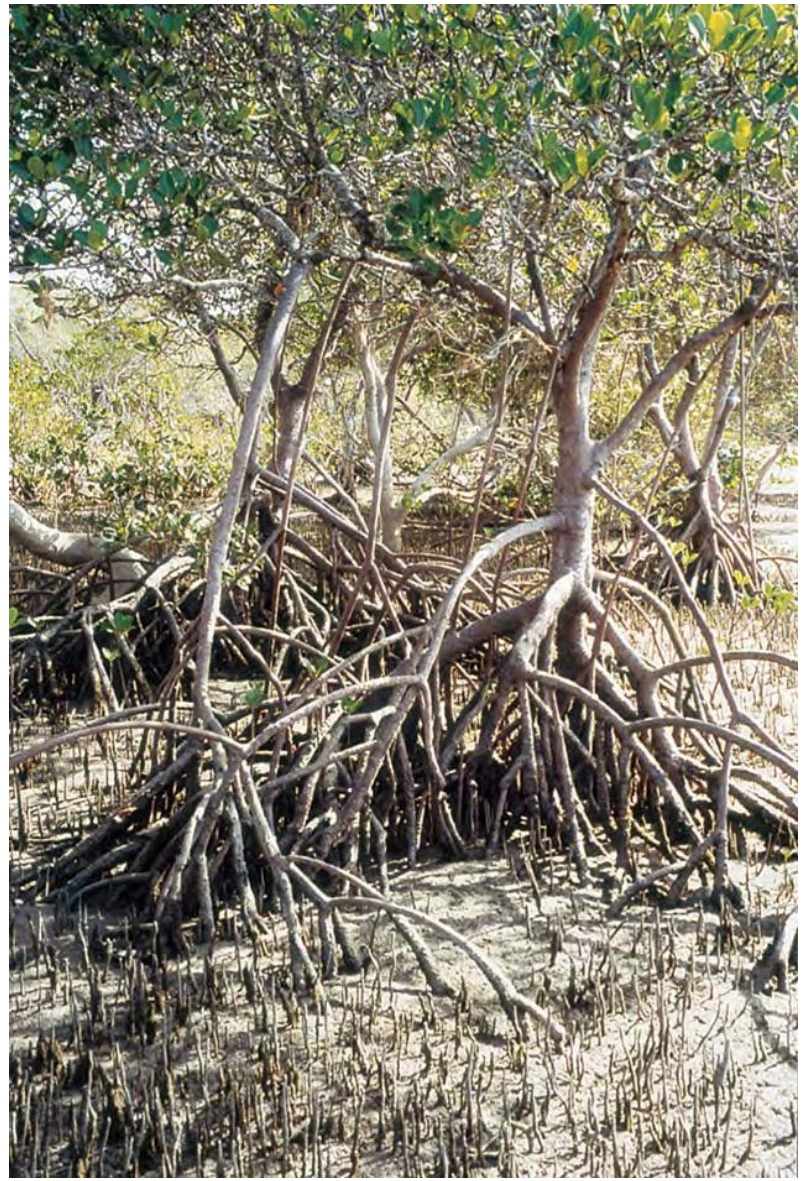
Read more at
https://en.wikipedia.org/wiki/Keystone_species

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Such species are described as playing a critical role in maintaining the structure of an ecological community, affecting many other organisms in an ecosystem and helping to determine the types and numbers of various other species in the community.

A keystone species is a plant or animal that plays a unique and crucial role in the way an ecosystem functions.

For example the mangrove grows along the shoreline in the tropics and its roots protect the soil from erosion. The roots also offer protection to small animals, including reef fish.



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Tiger sharks

These sharks will eat practically anything. This helps control populations of sea turtles and dugongs who may cause overgrazing of the sea grass in Australia. Since sea grass is where fish lay their eggs, overgrazing would lead to fewer fish.

"Without keystone species, the ecosystem would be dramatically different or cease to exist altogether".



By Albert kok - Own work, CC BY-SA 3.0, https://commons.wikimedia.org/w/index.php?curid=8969258

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Ochre seastars (Pisaster ochraceus), a keystone predator

By D. Gordon E. Robertson - Own work, CC BY-SA 3.0, https://commons.wikimedia.org/w/index.php?curid=6434470

Read more at

https://www.nature.com/scitable/knowledge/library/keystone-species-15786127

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California mussels (Mytilus californianus), the sea star's prey.



By Sharon Mollerus - California MusselsUploaded by JoJan, CC BY 2.0, https://commons.wikimedia.org/w/index.php?curid=9934254

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Corals, sea grasses and mangroves are also good examples of keystone species because they create habitat. Without these the ecosystem would not exist.



Neville Coleman

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Question

What do the following terms mean? Give an example of each.

1. Population size
2. Density
3. Abundance
4. Distribution (i.e. clumped, uniform, random)
5. Carrying capacity
6. Niche
7. K-strategists and r-strategists
8. Keystone species

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Consider using the table below in your answer.

Population term	Definition	Example / explanation
Population size		
Population density		
Population abundance		
Population distribution		
Clumped		
Uniform		
Randon		
Carrying capacity		
Niche		
r and K strategists		
Keystone species		

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T050 Assess population data



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Syllabus statement

At the end of this topic you should be able to ...

Assess

assess population data to measure population size, density, abundance, distribution, carrying capacity





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Assess

measure, determine, evaluate, estimate or make a judgment about the value, quality, outcomes, results, size, significance, nature or extent of something





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Question

As per syllabus

Assess population data to measure population size, density, abundance, distribution, carrying capacity.

So what is carrying capacity?



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Physical, economic and ecological

CARRYING CAPACITY IN COASTAL AREAS

The concept of capacity has received considerable attention as a result of increasing anthropogenic pressure in certain natural environments. Much consideration has recently been given to increases in coastal populations, with the implication that the carrying capacity of the world's coast is finite and such considerations form part of several coastal management initiatives (UNEP, 1996).

Johnson and Thomas (1996) argue that present interest in tourism capacity is due to growth in tourism combined with increasing awareness of environmental issues. The concept is particularly important in the coastal zone which is undergoing rapid change as a result of demographic changes and industrialization (see Kay and Alder, 1999, p. 21) in the context of global climate and sea-level change. In its broadest sense, carrying capacity refers to the ability of a system to support an activity or feature at a given level. In the coastal zone, these systems can vary greatly in both scale and type, and range from small salt marshes through large beach resorts to entire continental coasts. The activities or features that they support are also varied and include, for example, beach recreation or species abundance. The term "carrying capacity" does not therefore have a single precise definition. Rather, it is a broad term that covers a range of different concepts. These concepts are related by the idea that systems such as beaches have certain limits or

Physical carrying capacity: This is a measure of the spatial limitations of an area and is often expressed as the number of units that an area can physically accommodate, for example, the number of berths in

example, the physical integrity of the site, its ecological status, or its recreational value. In practice, these features may be interrelated.

The situation is further complicated by the subjective nature of certain limits. For example, the point at which the aesthetic impac ing becomes unacceptable is difficult to define and may vary location or cultural setting to another. In recognition of th nature of carrying capacity as a concept, a variety of types of capacity have been identified. Most of these fall into the follow gories: physical, ecological, social, and economic.

Physical carrying capacity: This is a measure of the spatial limitations of an area and is often expressed as the number of units that an area can physically accommodate, for example, the number of berths in a marina. Determining the physical capacity for certain activities can, however, become problematic when subjective elements are introduced. For example, the maximum number of people that can safely swim in a bay depends on human perceptions and tolerance of risk.

Ecological carrying capacity: At its simplest, this is a measure of the population that an ecosystem can sustain, defined by the population density beyond which the mortality rate for the species becomes greater than the birth rate. The approach is widely adopted in fisheries science (e.g., Busby *et al.*, 1996). In practice, species interactions are complex and the birth and mortality rates can balance over a range of population densities. In a recreational context, ecological carrying capacity can also be defined as the stress that an ecosystem can withstand, in terms of unacceptably affected. This approach raises the difficult question of defining ecological value and what constitutes an unacceptable change in it.

Social carrying capacity: This is essentially a measure of crowding tolerance. It has been defined as "... the maximum visitor density at which recreationists still feel comfortable and uncrowded" (De Ruyck *et al.*, 1997, p. 822). In the absence of additional changes, beyond this density visitor numbers start to decline. The social carrying capacity can, however, be influenced by factors such as the recreational infrastructure, visitor attitudes, and sociocultural norms.

Economic carrying capacity: This seeks to define the extent to which an area can be altered before the economic activities that occur in the area are affected adversely. It therefore attempts to measure changes in economic terms (Rees, 1992). Examples from the coastal zone might include examining the effect of increased numbers of trailer parks on agricultural activity in dune systems.

In addition to these s of composite measures ity. These attempt to d recreation by combinin actual carrying capacity of a coastal area assessed according to any of the above approaches depends largely on the nature of the area. Carter (1989, p. 357) noted that "Coastal environments vary considerably in their ability to absorb anthropogenic pressure. The carrying capacity of dune grassland is many orders of magnitude below that of rock cliffs." While this may be true, at least in some views of carrying capacity, it should be borne in mind that capacities are not necessarily fixed in time. They can often be altered by management practices for example, the provision of recreational facilities can increase the social carrying capacity of an area. They can also alter in response to wider environ-

Economic carrying capacity: This seeks to define the extent to which an area can be altered before the economic activities that occur in the area are affected adversely. It therefore attempts to measure changes in

Ecological carrying capacity: At its simplest, this is a measure of the population that an ecosystem can sustain, defined by the population density beyond which the mortality rate for the species becomes greater than the birth rate. The approach is widely adopted in fisheries science

contingent on technology, preferences, and the structure of production and consumption. They are also contingent on the ever-changing state of interactions between the physical and biotic environment."

M. MacLeod and J.A.G. Cooper

Cross-references

Springer
http://www.springer.com/978-1-4020-1903-6
Encyclopedia of Coastal Science
Schwartz, M. (Ed.)
2005, LXVI, 1213 p., Hardcover
ISBN: 978-1-4020-1903-6

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Ecological carrying capacity

The size of a population is affected by four processes: "BIDE"

Birth rate (B),

Immigration rate (I)

Death rate (D),

and

Emigration rate (E).

The rate of change of a population (R) is calculated by $R = (B + I) - (D + E)$. "BIDE"

When a population reaches its carrying capacity due to the limitation of resources there will be zero population growth:

R = 0.

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The syllabus says

Use models to examine factors that influence changes in population (BIDE)

One such model can be found at wiki

By Lev Kalmykov - Own work, CC BY-SA 4.0, https://commons.wikimedia.org/w/index.php?curid=41287678



Reference:

https://en.wikipedia.org/wiki/Population_model#/media/File:Logical_deterministic_individual-based_cellular_automata_model_of_single_species_population_growth.gif

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In this model

Logical deterministic individual-based cellular automata model of an ecosystem with one species.

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Population model

From Wikipedia, the free encyclopedia

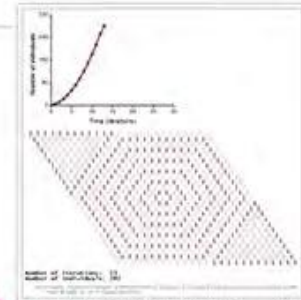
A population model is a type of mathematical model that is applied to the study of population dynamics.

Contents [hide]

1 Rationale
2 History
3 Equations
4 Examples of individual-based models
5 See also
6 References
7 External links

Logistic growth equation:

$$\frac{dN}{dt} = rN\left(1 - \frac{N}{K}\right)$$



Logical deterministic individual-based cellular automata model of an ecosystem with one species. The model demonstrates a mechanism of S-shaped population growth.

Rationale [edit]

Models allow a better understanding of how complex interactions and processes work.

Modeling of dynamic interactions in nature can provide a manageable way of understanding how numbers change over time or in relation to each other.

Many patterns can be noticed by using population modeling as a tool.[1]

Ecological population modeling is concerned with the changes in parameters such as population size and age distribution within a population. species.[2]

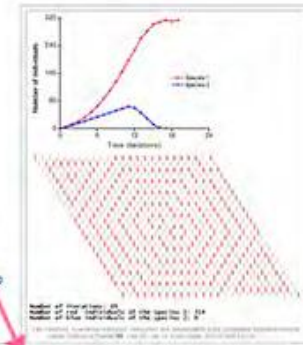
Population models are used to determine maximum harvest for agriculturists, to understand the dynamics of biological invasions, and for environmental conservation.

Another way populations models are useful are when species become endangered. Population models can track the fragile species and work and curb the decline. [1][2]

Equations

Logistic growth equation:

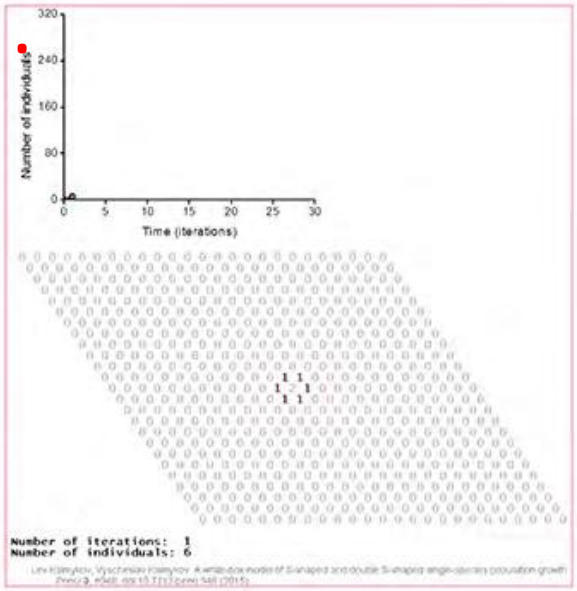
$$\frac{dN}{dt} = rN\left(1 - \frac{N}{K}\right)$$

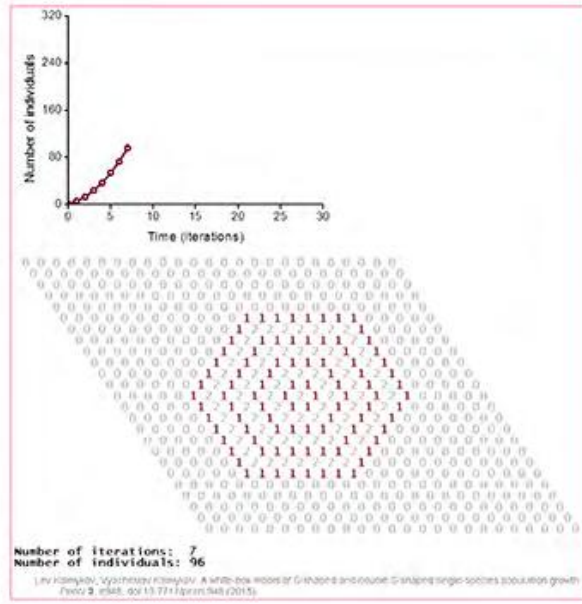


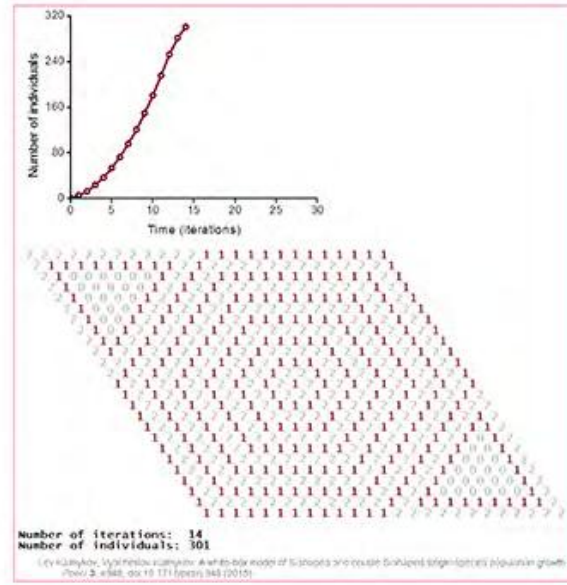
Logical deterministic individual-based cellular automata model of interspecific competition for a single limited resource. A mechanism of competitive exclusion of one species by another.

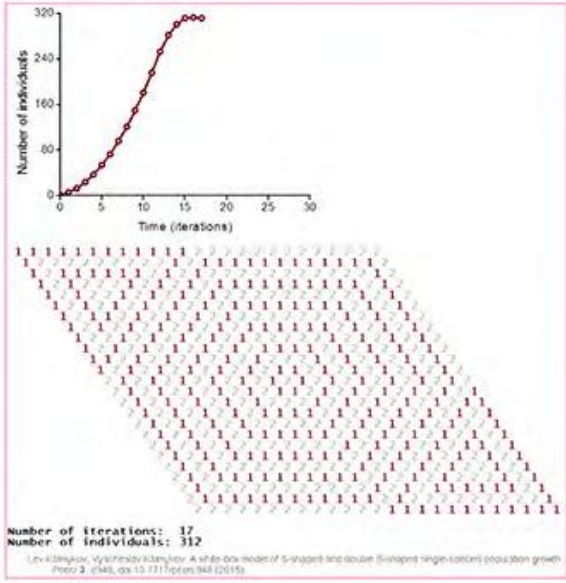
A mechanism of competitive exclusion of one species by another.

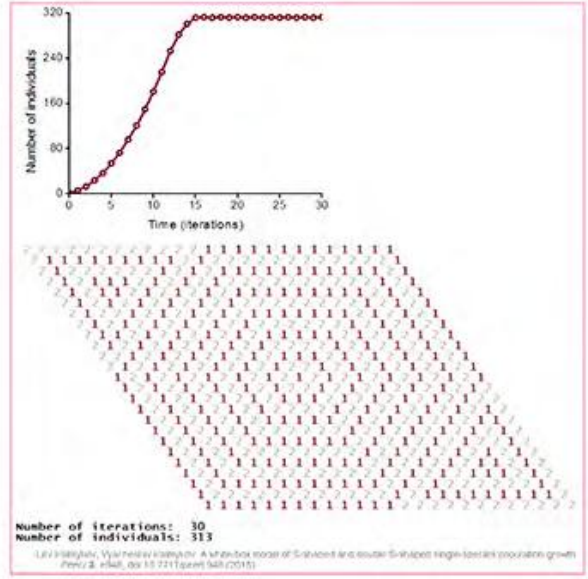
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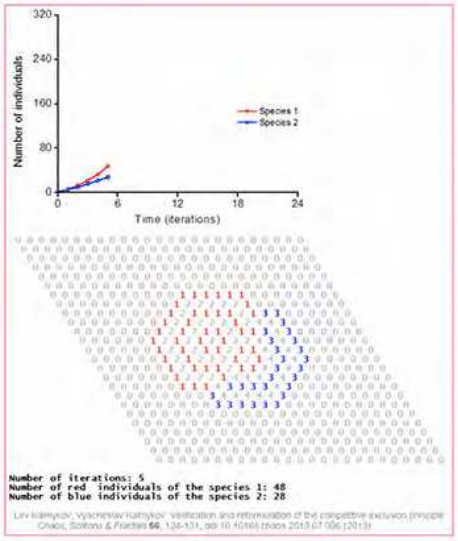


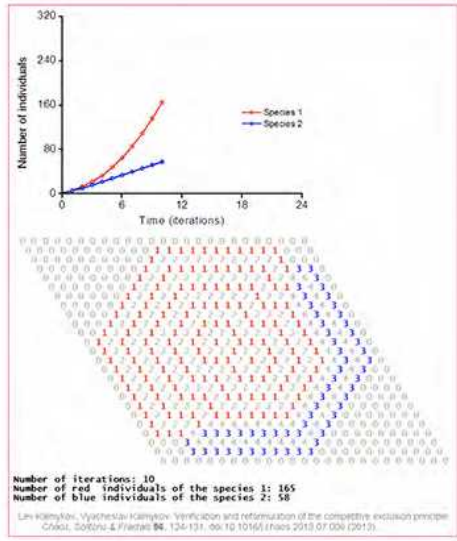


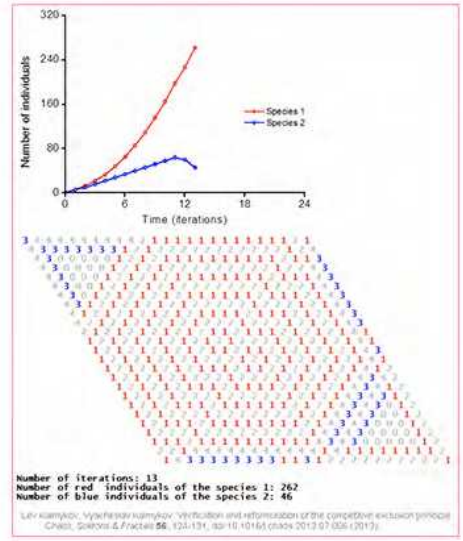
The model demonstrates a mechanism of S-shaped population growth.

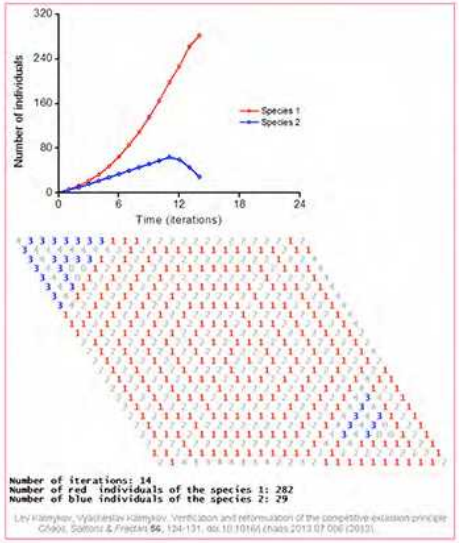
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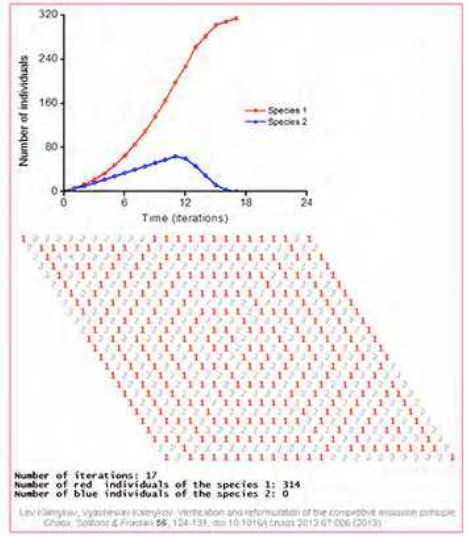
Add a second species and relevant data and the formula will predict which species gets excluded.











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So, in your data collection you need to look for evidence of this. Look for things like:

- One species of mangrove excluding another.
- Soldier crabs excluding mud welks.



Bob Moffatt

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Activities

Estimate the population size, density and the distribution of plants and invertebrates within a local mangrove system.

E.g. survey count, quadrats, species density, percentage coverage, direct observation.



Bob Moffatt

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Use a range of field equipment to measure abiotic factors (light, temperature, salinity) related to mangrove systems in the local area.
(See also rocky shore investigation T056)

Nitrate kit



Phosphate kit



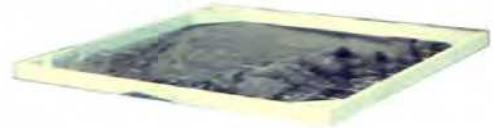
Salinity meter



Profile stick



Transect square



Temperature probe





Dissolved oxygen meter

pH meter



Digital Anemometer



Waterproof camera



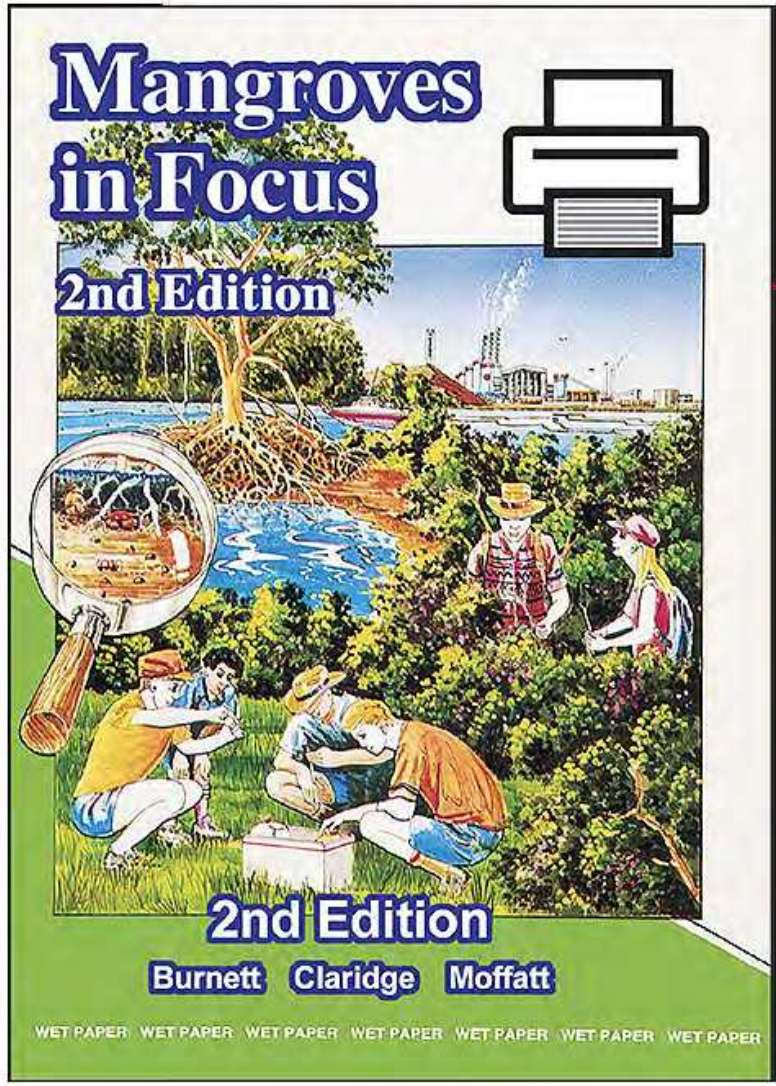
Compilation by Bob Moffatt –
see suppliers website for details)

Equipment reference

https://www.ehp.qld.gov.au/water/monitoring/sampling-manual/pdf/biological-assessment-monitoring-mangrove-forest-health.pdf

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Use field guides in mangroves.



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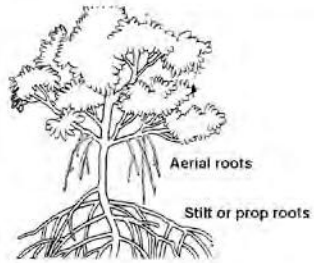
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Identify four mangrove species

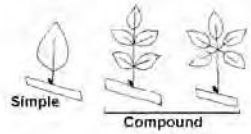
(*see page 36 of Mangroves in Focus*)

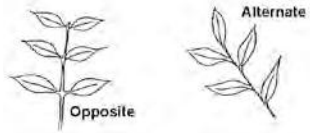
Morphology key

These keys are based on visual identification of plants.



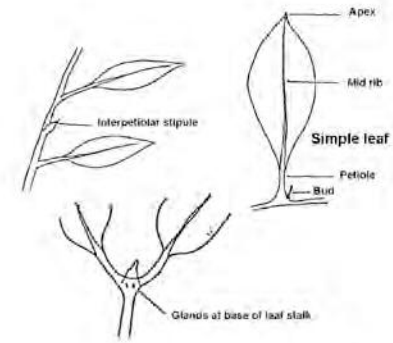


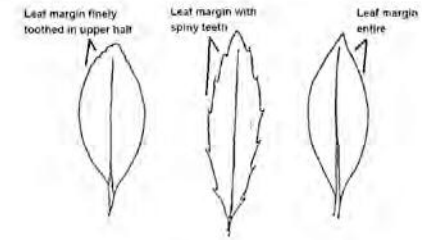


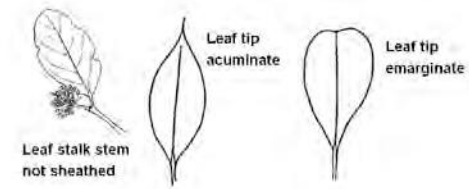


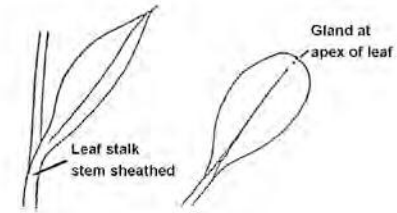
based on an original exercise by staff at Ingham State High School.

	Characteristic	Genus / species
1.	Stilt roots and/or knee roots present	go to 2
	Stilt roots and/or knee roots absent	go to 3
2.	Aerial prop roots	*Rhizophora* sp.
	No aerial prop roots	*Bruguiera* sp.
3.	Leaves compound	go to 4
	Leaves simple	go to 5
4.	Mid rib vein central	*Xylocarpus* sp.
	Mid rib vein slightly off centre	*Cynometra iripa*
5.	Leaves opposite	go to 6
	Leaves alternate	go to 10
6.	Underside of leaf grey	*Avicennia* sp.
	Underside of leaf not grey	go to 7
7.	Interpetiolar stipules present	*Scyphiphora* sp.
	Interpetiolar stipules absent	go to 8
8.	Leaf stalk with two glands at base	*Sonneratia* sp.
	Leaf stalk without glands at base	go to 9
9.	Leaf margin finely toothed in upper half	*Osbornia* sp.
	Leaf margin with spiny teeth	*Acanthus* sp.
	Leaf margins entire	*Ceriops* sp.
10.	Leaf underside grey	go to 11
	Leaf underside not grey	go to 12
11.	Leaf tip acuminate	*Heritiera* sp.
	Leaf tip emarginate	*Camptostemon* sp.
12	Latex (milky sap) present	*Excoecaria* sp.
	No latex	go to 13
13.	Gland at leaf apex	*Lumnitzera* sp.
	No gland at apex	go to 14
14.	Leaf stalk stem sheathed	*Aegialitis* sp.
	Leaf stalk not sheathed	*Aegiceras* sp.





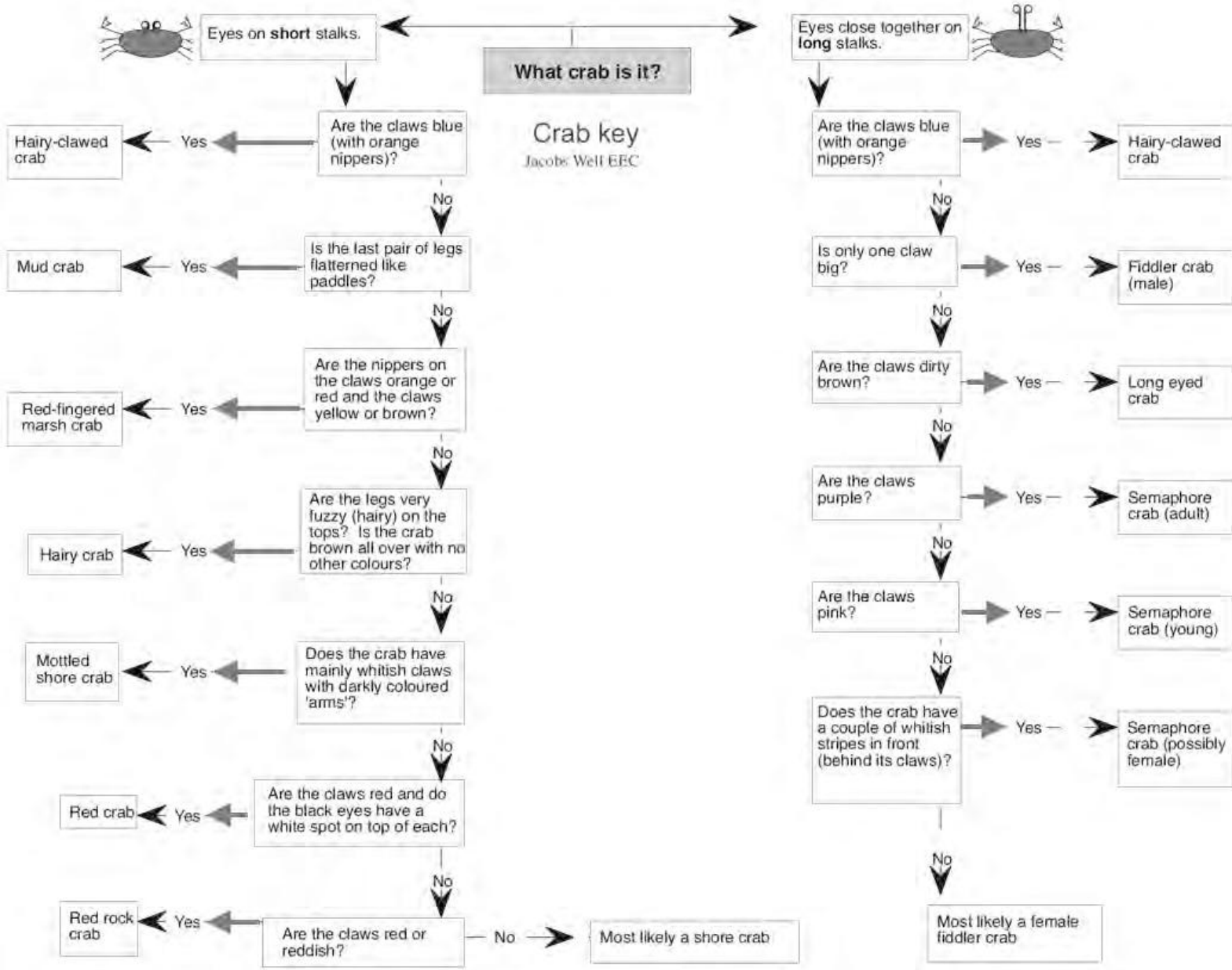




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Identify three crab species

(see page 41 of Mangroves in Focus)



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Recall the procedures involved in the identification and construction of food chains and as part of the follow up work from the mangrove field trip, apply this to the mangrove system.

Compile list and sort into categories

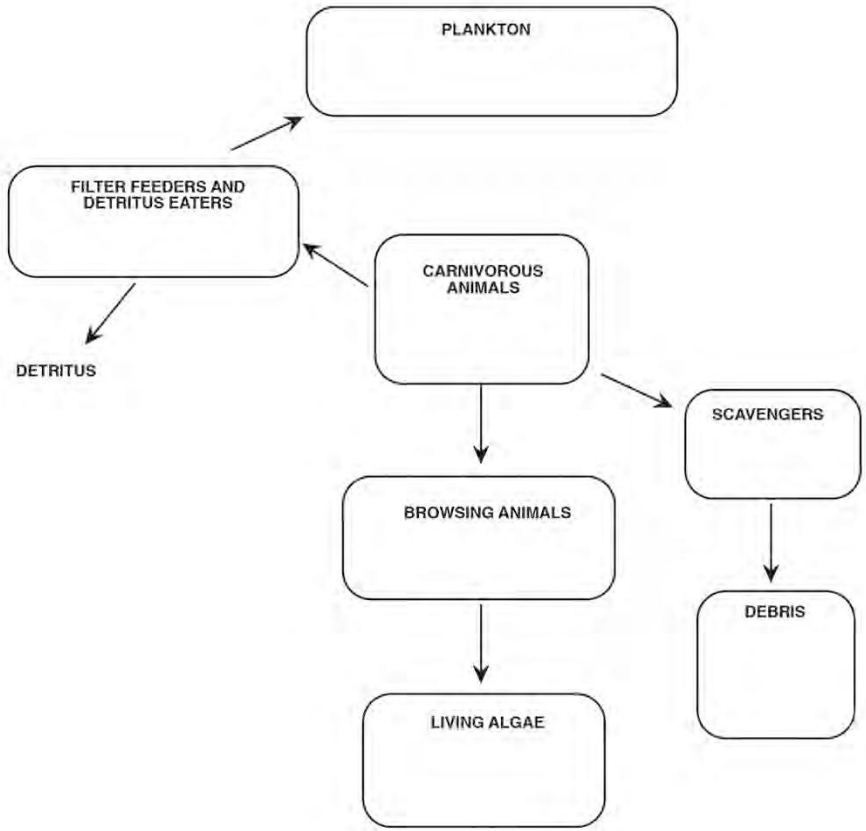
(See page 85 Mangroves in focus)

Producers	Herbivores	Predators	Scavengers	Decomposers

Figure 85.2 Food web table

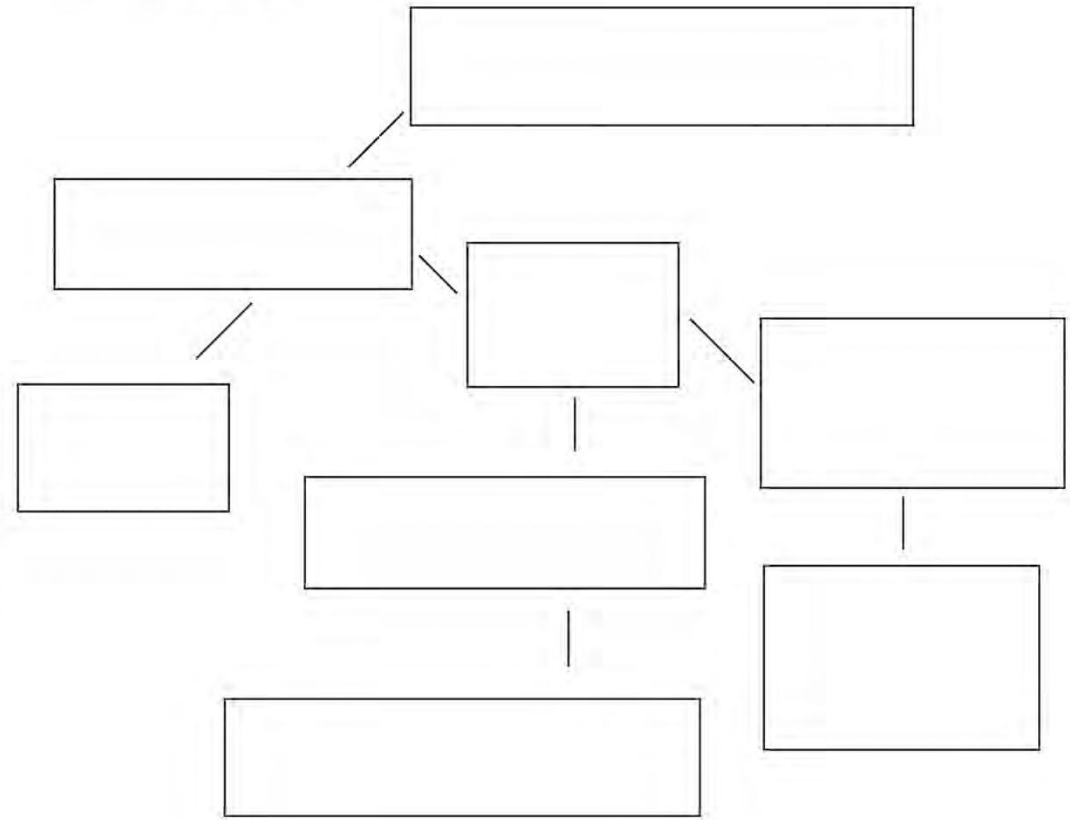
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Use this collated data to identify biotic components of a mangrove ecosystem (i.e. food chains and food webs).
Use the “fill in the boxes method” below devised by Pope and McDonald to draw a draft food chain.



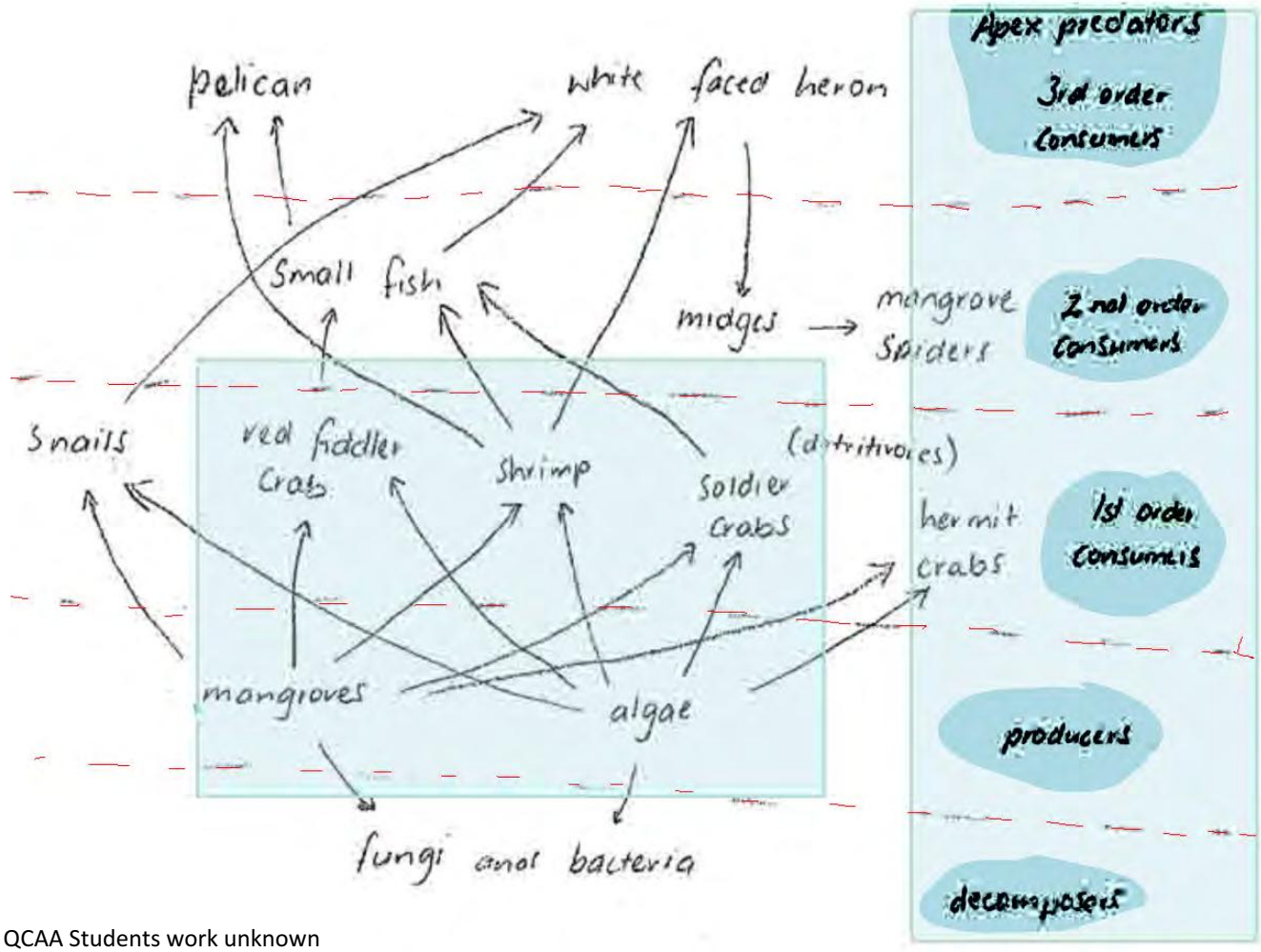
Food relationships of animals (Pope and McDonald (1968) in Below High Water. SA Department.)
Reproduced with permission

Food chain for your data



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Now draw lines or use colours to classify organisms in the collated data into trophic levels.



QCAA Students work unknown

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Syllabus says

Identify their niche within the ecosystem.

An ecological niche is

- the role and position a species has in its environment
- how it meets its needs for food and shelter
- how it survives, and reproduces.

Example

Archer Fish spitting at flying insects, using the air above water as a ecological niche.

The Archer fish is using the ecological niche of the " air above water " and has adapted to this niche by being able to spit water at flying insects.

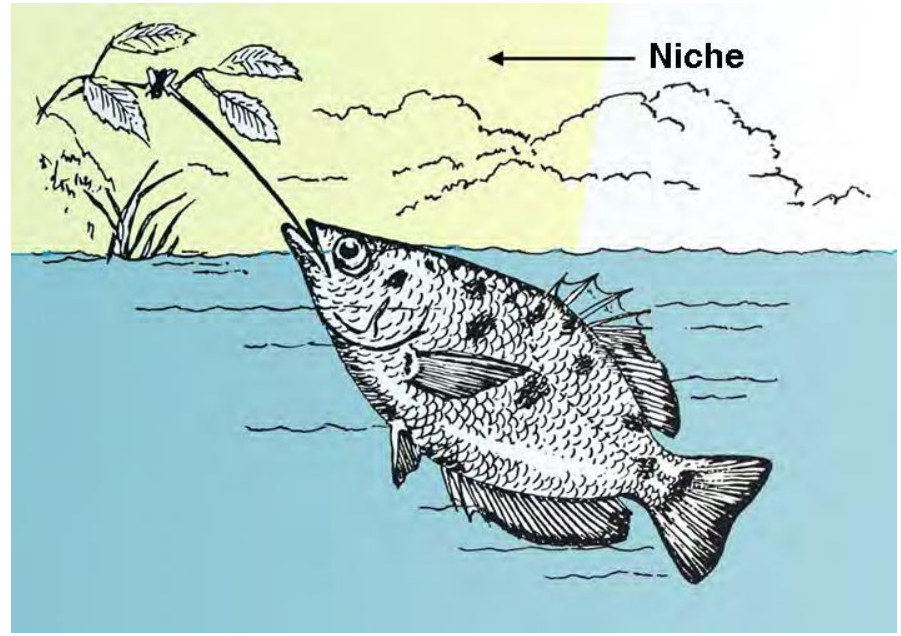


Illustration of an archerfish shooting water at a bug on a hanging branch
By Pearson Scott Foresman - Archives of Pearson Scott Foresman, donated to the Wikimedia FoundationThis file has been extracted from another file: PSF A-50002.png, Public Domain, https://commons.wikimedia.org/w/index.php?curid=3596173

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Syllabus says

Identify the niche of the organism listed in the mangroves.

For example

- Crabs are the most abundant and important larger invertebrate in mangroves.
- When building their burrows, crabs improve the penetration of ground water, water from high tides and freshwater runoff.
- This helps to flush out excess salt and reduce soil salinity.
- The burrows also increase oxygen levels in the mud by creating air spaces.



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Crab holes also provide a habitat for many organisms, including fish molluscs and worms. Crabs are vital to the recycling of nutrients, in particular nitrogen.

Many crabs eat large amounts of fallen mangrove litter while other species eat algae and detritus.

The presence of crabs in these ecosystems has been shown to improve the growth of mangrove plants, and also increases the biomass and diversity of other organisms.



By Cory, CC BY-SA 3.0,
https://commons.wikimedia.org/w/index.php?curid=3004103

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The syllabus says

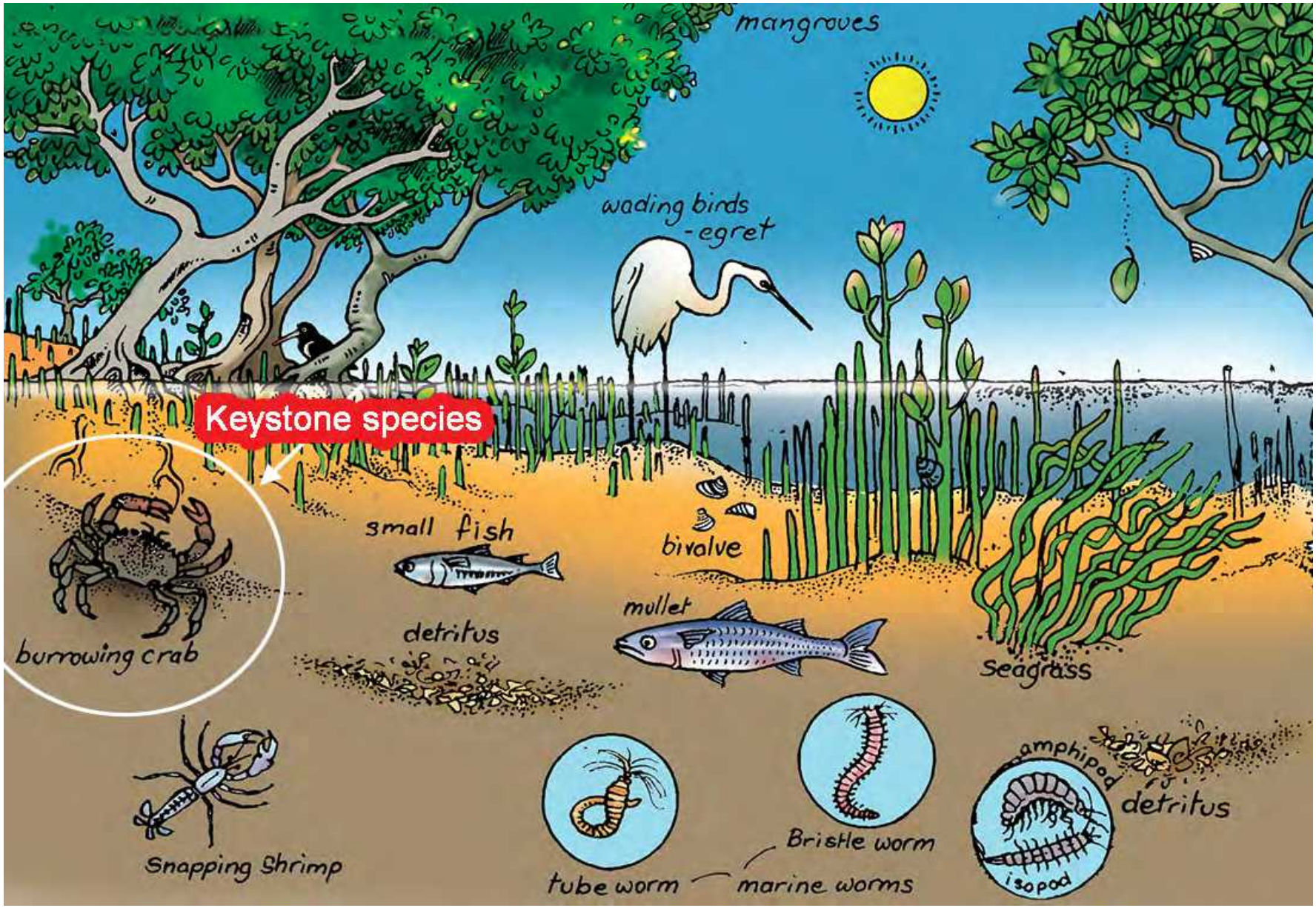
Use the observations and secondary sources to identify keystone species in the mangrove ecosystem, providing evidence based on research and collected data to support these statements.

Observation

Why are there no leaves on a mangrove boardwalk? Do crabs eat them at night? If so, are they crucial to removing leaf litter making them a keystone species?

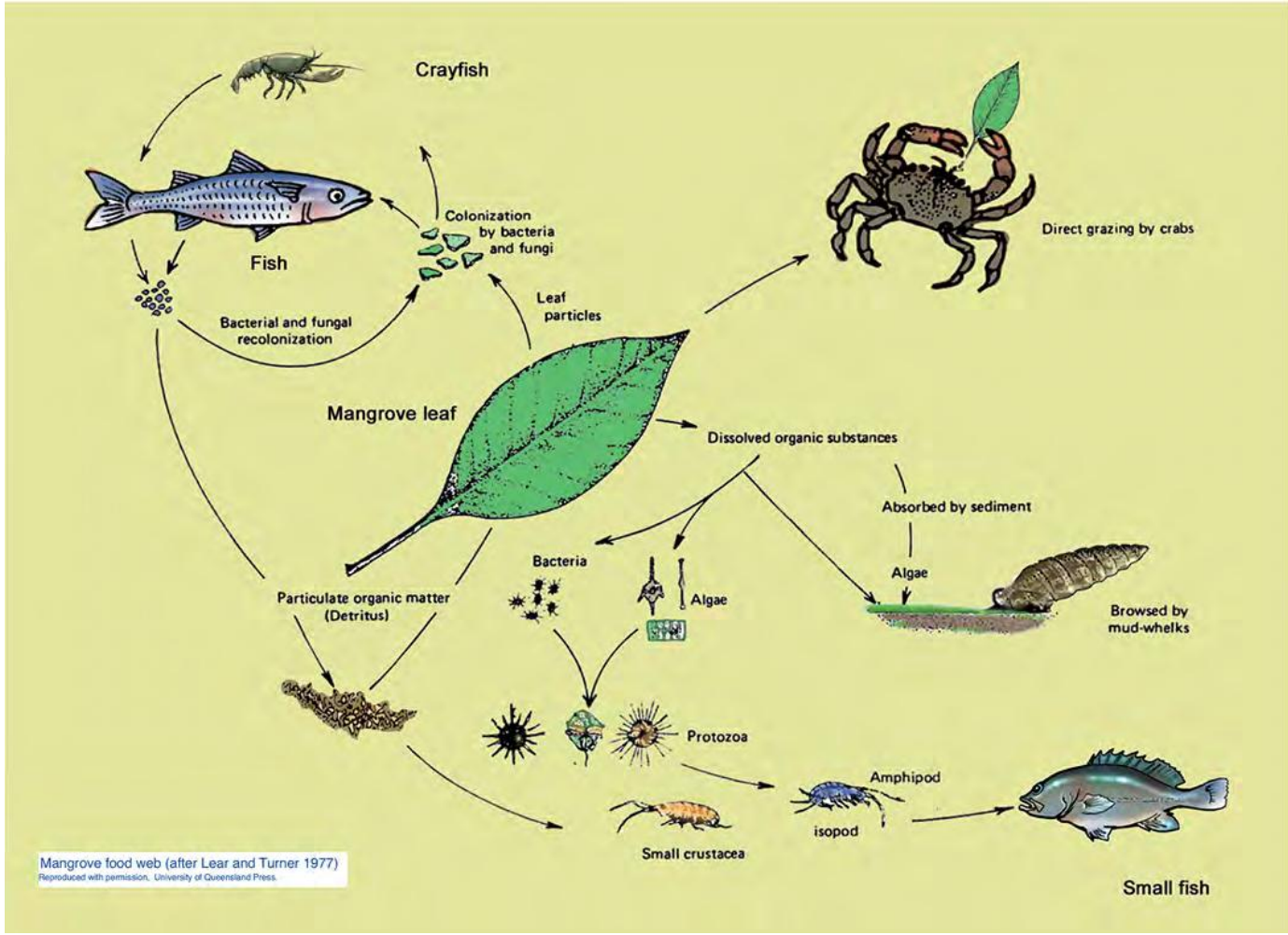


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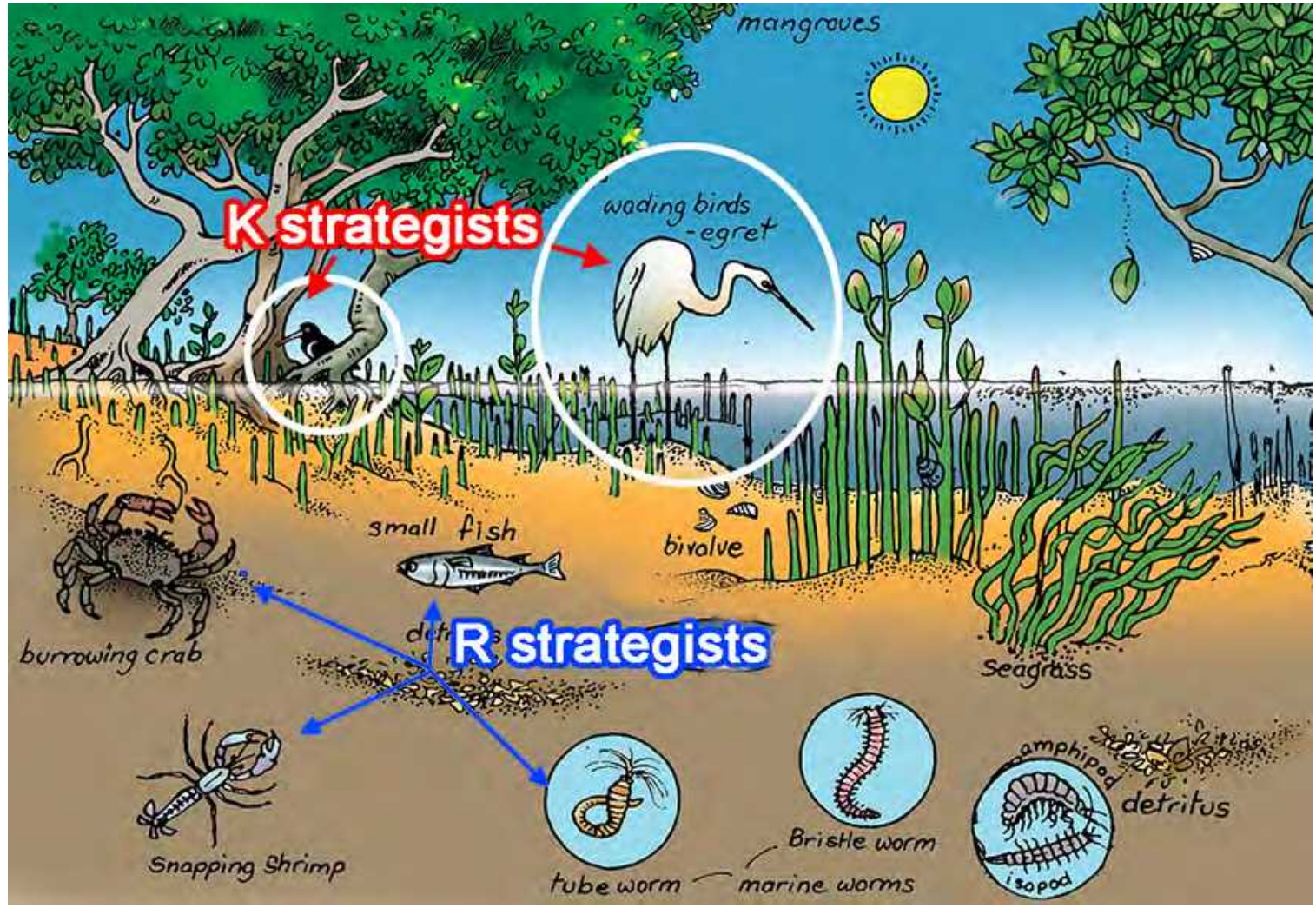
Principal role as a keystone species is to recycle carbon. There are many others.



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Use the observations and secondary sources to identify k and r strategists in the mangrove ecosystem, providing evidence based on research and collected data to support these statements.

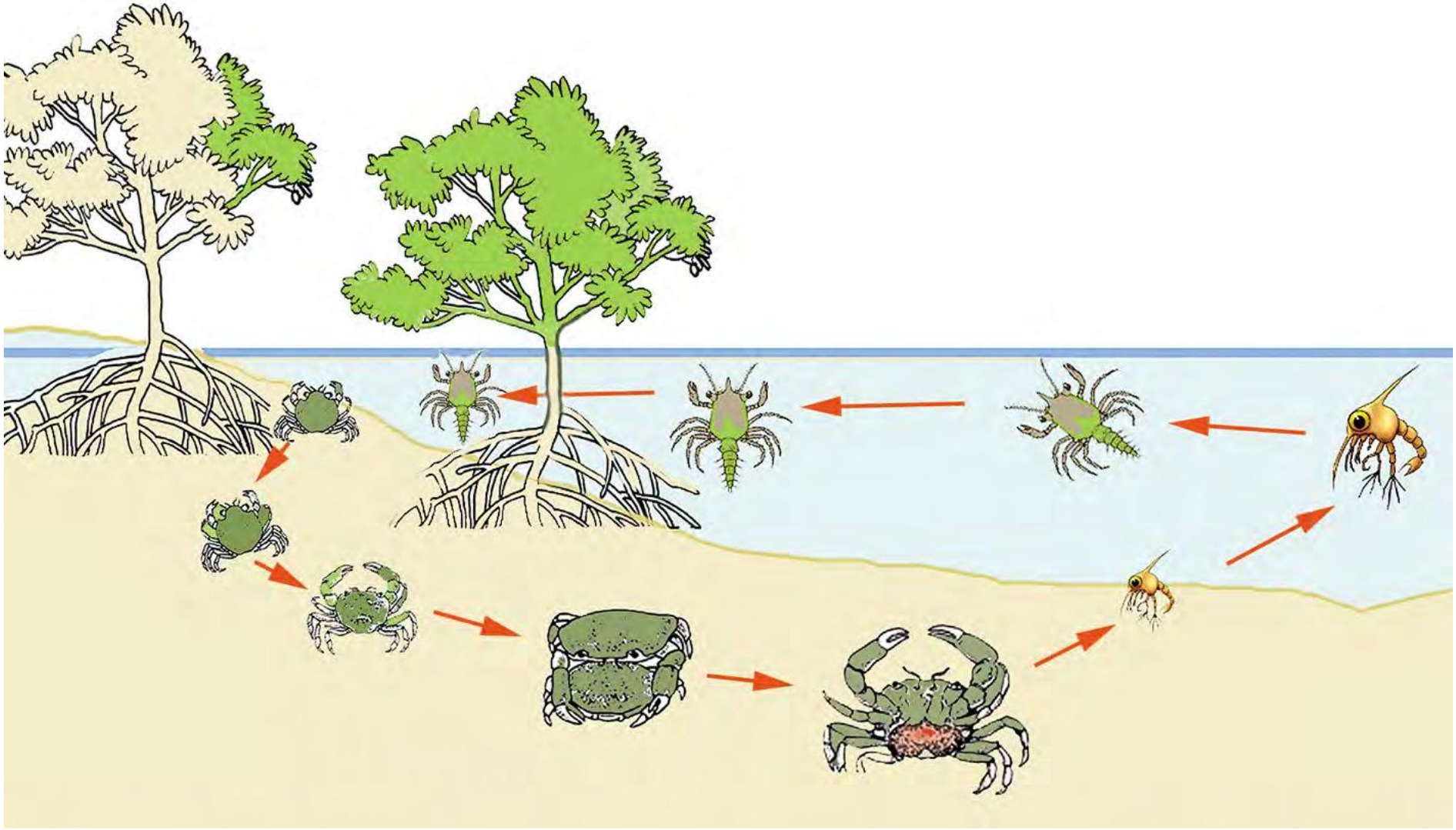
K-selection strategy, with few offspring, long gestation, long parental care, and a long period until sexual maturity.



Kerry Kitzelman Sharyn Madder

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Crabs have an *r*-selection strategy, with many offspring, short gestation, less parental care, and a short time until sexual maturity.



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Using examples from the mangrove ecosystem food web, analyse the flow of toxic non-biodegradable material through a food web.

Consider the sediment concentration of heavy metals and PCBs (industrial chemicals) and the concept of bioaccumulation.

Possible investigation

You could “spike” this jar of mangrove mud with a heavy metal to see how microorganisms concentrate the metal.



John Burnett

© Wet Paper Publications

The syllabus says include ciguatera as a further example of bioaccumulation.

Look at these photos and if one of these fish are found in the mangroves, include it in your discussions.

Refer back to
Topic T048

Search for
Ciguatera.

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Ciguatoxic fishes

Ciguatera poisoning generally occurs several hours after eating reef fishes from tropical and subtropical regions. It is most common in relatively large specimens of a small group of higher order predatory species, but numerous other reef fish species have been involved on a more occasional basis. Its incidence is highly unpredictable within individuals of a particular species and between fish from different locations.

Fishes known to often have ciguatoxin in their flesh include:

- moray eels (*Gymnothorax* species)
- Chinamanfish (*Symphorus nematophorus*)
- Paddletail (*Lutjanus gibbus*)
- Red Bass (*Lutjanus bohar*)
- barracudas (*Sphyraena species*)

These species are either 'no take' under Fisheries regulations, or not accepted for sale by fish marketing bodies, so are rarely eaten in Australia.

More occasional problems have been noted for coral trouts (*Plectropomus* species), rock cods (*Epinephelus* species), emperors (*Lethrinus* species), tropical snappers (*Lutjanus* species) and Spanish Mackerel (*Scomberomorus commerson*), all of which are very popular commercial and recreational angling species. These species are implicated in a large proportion of the reported cases of ciguatera poisoning, however the prevalence of ciguatoxin among these groups as a whole is extremely low in Australia. A single large fish can cause an 'outbreak' of poisoning, as portions of one fish can potentially be sold to and eaten by many different consumers.

There is no reliable method of determining in advance whether a fish contains ciguatoxin. However, high risk species should not be eaten, large specimens of lower risk species should be avoided, and it is best for only modest amounts of any tropical reef fish to be eaten, at least until it is confirmed to be safe. If large or suspect fish are to be eaten, a useful approach is for an adult within a group to eat only a very small portion in the first instance, with no follow up meals of the same fish until the following day. If no symptoms ensue, the fish is most likely fit for general consumption.



Sieve Moray, *Gymnothorax cribroris* (Photo: Ian Banks).



Chinamanfish, *Symphorus nematophorus* – juvenile (Photo: Ian Banks).



Chinamanfish, *Symphorus nematophorus* – adult (Photo: Ian Banks).



Paddletail, *Lutjanus gibbus* closeup (Photo: Ian Banks).



Paddletail, *Lutjanus gibbus* in school (Photo: Ian Banks).



Red Bass, *Lutjanus bohar*.



Pickhandle Barracuda, *Sphyraena jello* (Photo: Ian Banks).

http://www.qm.qld.gov.au/Find+out+about/Animals+of+Queensland/Fishes/Fish+poisoning/Ciguatoxic+fishes#.W58q4JMzbUZ

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The syllabus says

Recall carbon cycle and relate this to build up of organic matter and the productivity of the mangrove system. Use this as a starting point.

Executive summary

Carbon production

- Mangrove net primary production averages 11.1 t dry weight ha^{-1} $year^{1}$, roughly equivalent to tropical terrestrial forests.
- Mangroves may constitute a carbon sink for up to a century.

Carbon allocation & storage

- Belowground biomass is equivalent to aboveground biomass in mangroves.
- Most carbon in mangroves is stored as large pools of soil carbon and belowground roots.
- Storage of carbon in mangroves averages 937 tC ha^{-1}.

Mechanisms facilitating sediment accretion

- Mangroves actively facilitate accumulation of carbon and other elements associated to fine particles.

Rates of soil accretion & carbon sequestration

- Rates of soil accretion in mangroves average 5 mm $year^{-1}$.
- Frequency if tidal inundation is the main factor controlling accretion.
- Global carbon burial rates for mangroves approximate 24 TgC $year^{-1}$.

Significance of mangroves to terrestrial & marine carbon sequestration

- Mangroves account for 3% of carbon sequestered by the world's tropical forests, but 14% of carbon sequestered in the world's ocean.
- If disturbed, mangroves may emit 0.02–0.12 PgC $year^{-1}$, equal to 2–10% of global deforestation emissions.

Future perspective

- Mangroves are prime candidates for REDD+ and blue carbon projects, but a number of issues and specific actions must be carefully addressed prior to commencement of such projects.

https://www.researchgate.net/publication/274116107_Carbon_sequestration_in_mangrove_forests

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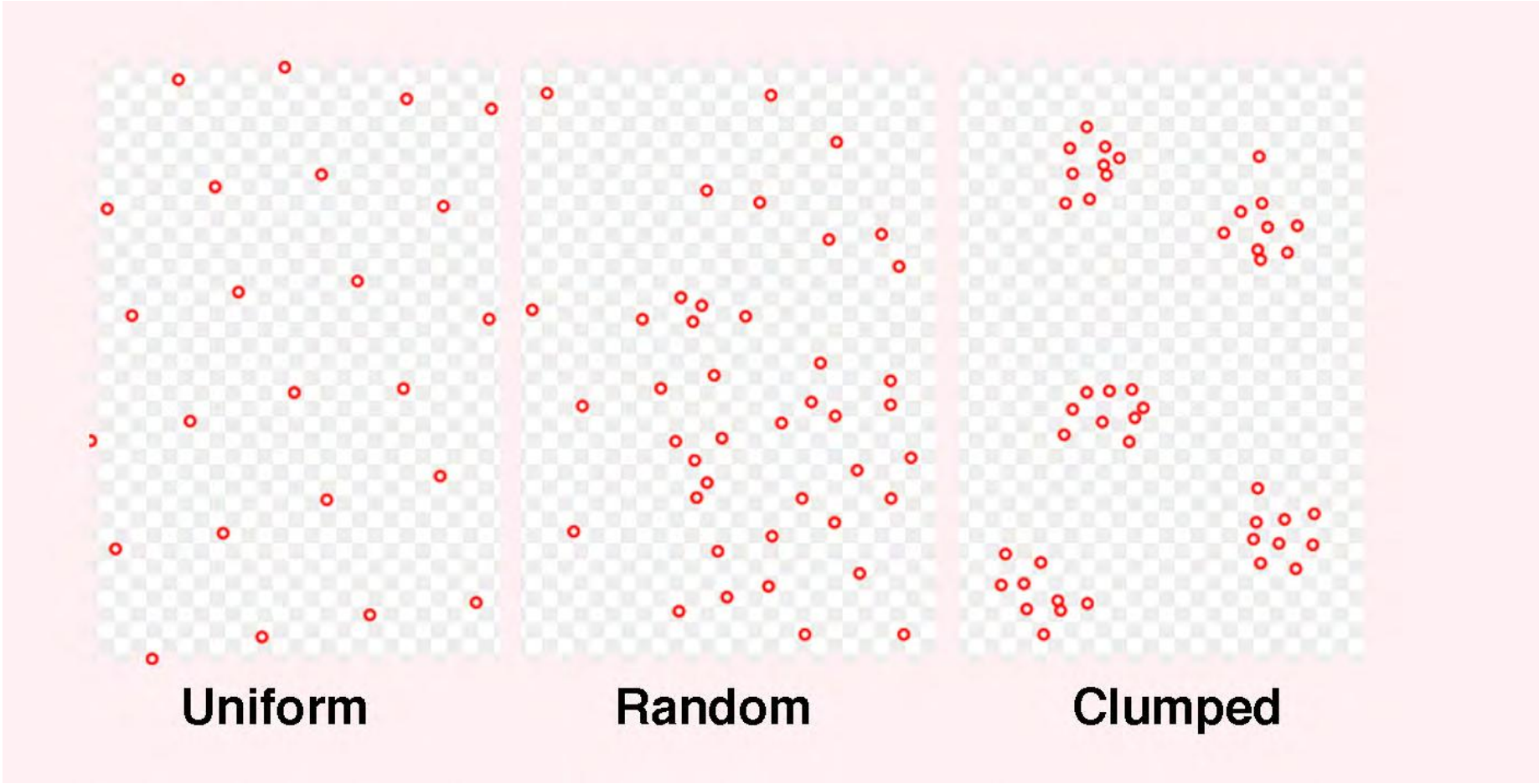
Use collected data *to construct transect graphs that compare the distribution (i.e. clumped, uniform, random) and species diversity of the local mangrove system to systems in northern Queensland and South East Queensland.*

Variable	Quadrat 1	Quadrat 2	Quadrat 3	Quadrat 4	Quadrat 5
Height above low tide mark (m)					
Wind direction N,N/E etc					
Wind speed km/hr					
Air temperature ^{o}C					
Mud temperature ^{o}C					
Relative humidity %					
Mud composition					
Mud salinity					
Mud pH					
Light intensity (canopy)					
Light intensity (ground level)					
Ground cover %					

Variable	Quadrat 1	Quadrat 2	Quadrat 3	Quadrat 4	Quadrat 5
Animals present					
Mangrove species present					
Other plant species					

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Remember Topic T049



Bob Moffatt

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Relate the distribution of mangrove species to the limiting factors and tolerance limits.
Add data from the table and comment on zonation. Note: Shelford's law is done in T54.

Variable	Quadrat 1	Quadrat 2
Height above low tide mark (m)		
Wind direction N,N/E etc		
Wind speed km/hr		
Air temperature ^{o}C		
Mud temperature ^{o}C		
Relative humidity %		
Mud composition		
Mud salinity		
Mud pH		
Light intensity (canopy)		
Light intensity (ground level)		

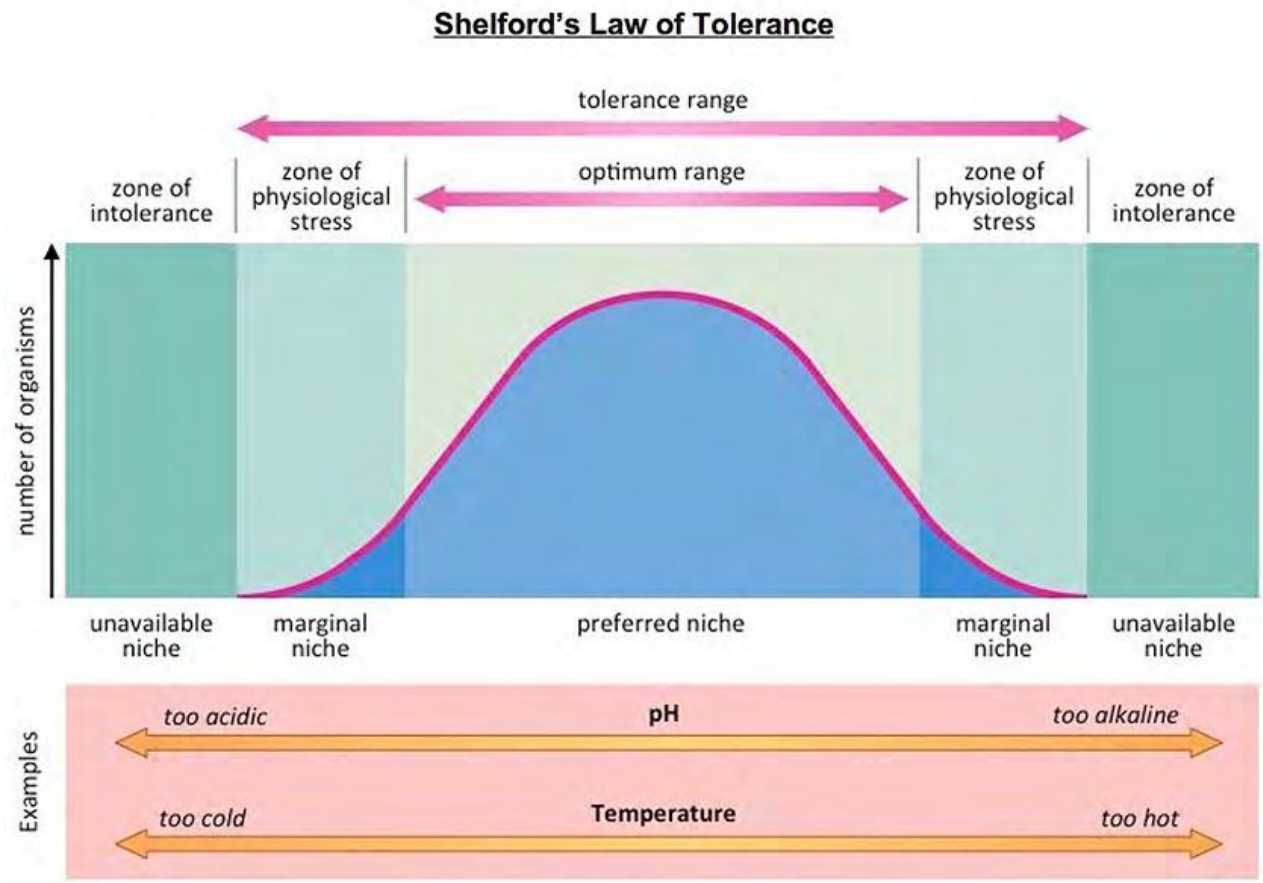
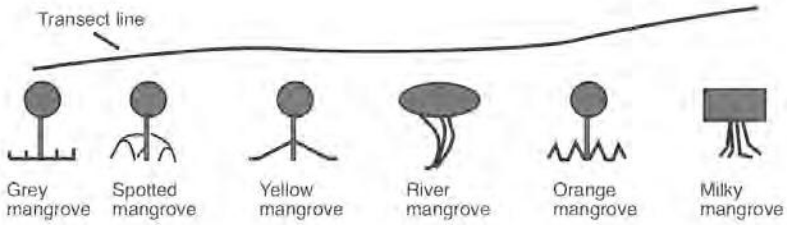
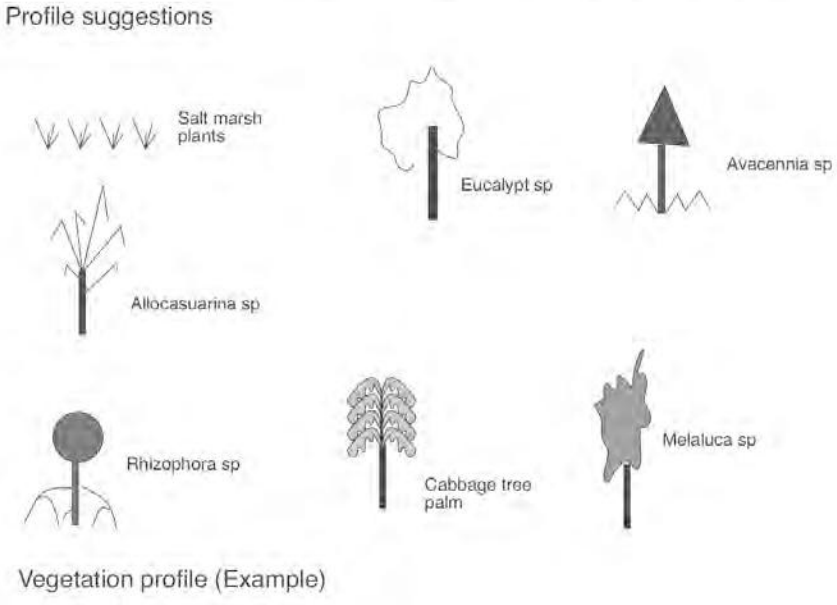


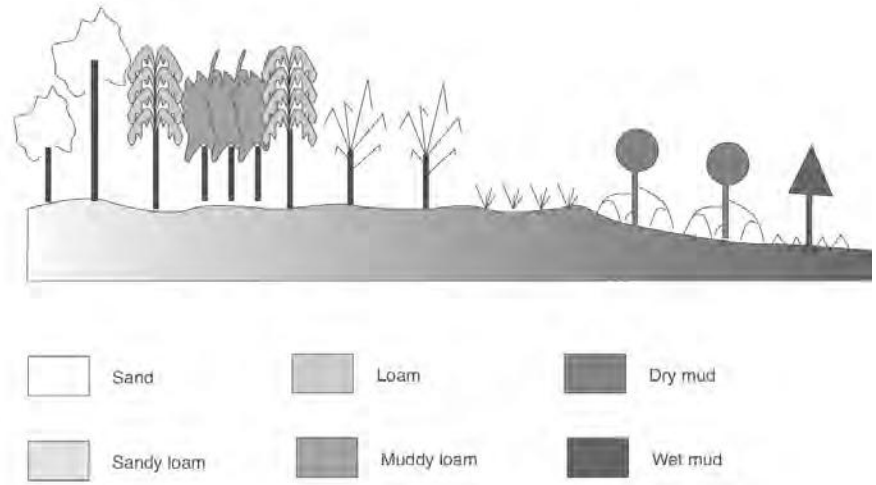
Illustration Bob Moffatt adapted from:
http-//ib.bioninja.com.au/options/option-c-ecology-and-conser/c1-species-and-communities/survival-factors.html.jpg

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Illustrate your answer using a key like this one:







Bob Moffatt

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Using secondary sources examine J curve distribution patterns, predator-prey graphs to draw conclusions about population changes and carrying capacity.

Remember

J-shaped growth curve is a curve on a graph that records the situation in which, in a new environment, the population density of an organism increases rapidly in an exponential (logarithmic) form, but then stops abruptly as environmental resistance (e.g. seasonality) or some other factor (e.g. the end of the breeding phase or resources run out) suddenly becomes effective.

It may be summarized mathematically as: $dN/dT = r$ (with a definite limit on N) where N is the number of individuals in the population, T is time, and r is a constant (positive or negative) representing the biotic potential of the organism concerned.

Population numbers typically show great fluctuation, giving the characteristic 'boom and bust' cycles of some insects, or the pattern seen in algal blooms.

This type of population growth is termed 'density-independent' as the regulation of growth rate is not tied to the population density until the final crash.

Compare S-shaped growth curve representing the real world where the curve flattens out as the environment's resources are limited indicating carrying capacity (K).

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Good luck



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Chapter 9 Abiotic components of marine ecosytems



T051 Air and water comparisons

T052 Abiotic factors of marine ecosystems

T053 Limiting factors and tolerance limits

T054 Assess tolerance limit data

T055 Apply zonation concepts

T056 Population dynamic investigation

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T051 Air and water comparisons



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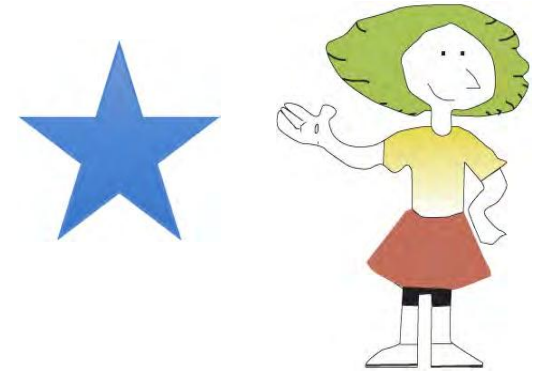
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Syllabus statement

At the end of this topic you should be able to ...

Understand

that marine ecosystems are influenced and limited by abiotic factors in ways that may be different from terrestrial ecosystems due to the different physical and chemical properties of water compared to air.



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Understand

is defined as to

- know the meaning of something or to grasp the situation;
- present remembered ideas, facts or experiences;
- become familiar with the idea that …



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Introduction

The sea is very different from the land.

If you climb a mountain on the Great Dividing Range what do you see?

Clouds, valleys, rivers, hills and plains.

We can easily feel, smell, touch, taste and hear abiotic factors here each day, every day.



Land look out

Photo Bob Moffatt

© Wet Paper Publications

If you go to your local headland or beach and look out at sea - what do you see?

All you see is water and although 80% of us all live within an hours drive of the sea, we experience these abiotic factors less.

So the study of abiotic factors in the sea, is more difficult than on land.



Sea look out

Photo Bob Moffatt

© Wet Paper Publications

On land, wind and water affect the cattle in a field.

If there is a drought, water and food can be provided and they can be fenced in.



Cattle behind a fence
Bob Moffatt

© Wet Paper Publications

However the ocean knows no boundaries.

Species are free to move without fences and it is difficult to provide food.

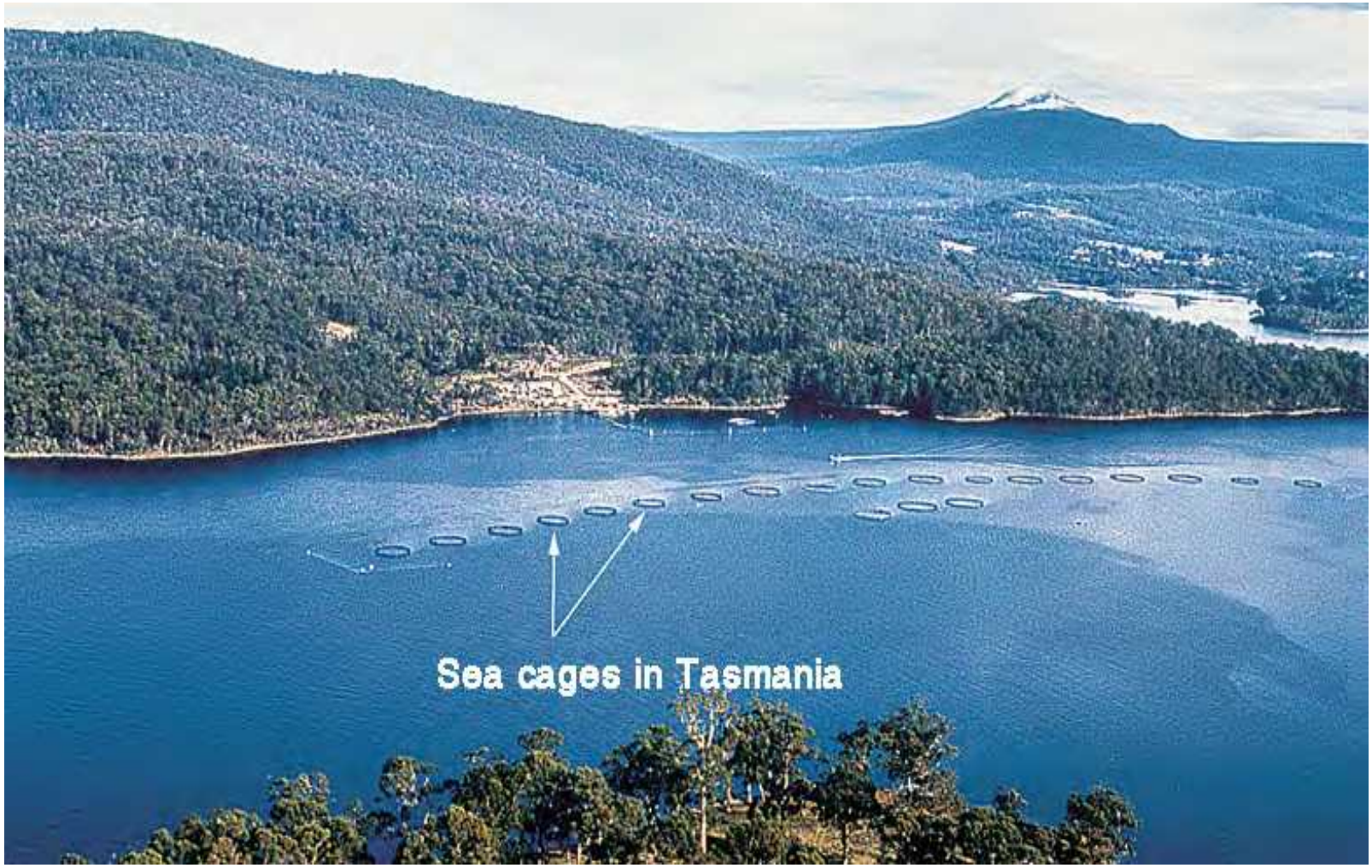


Fish in a school

Photo Viewfinder

© Wet Paper Publications

Unless the fish are enclosed in a pen.



Sea cages in Tassie

Photo Bob Moffatt

© Wet Paper Publications

If a disease breaks out on land, you can quarantine an area by stopping movement of people and animals.

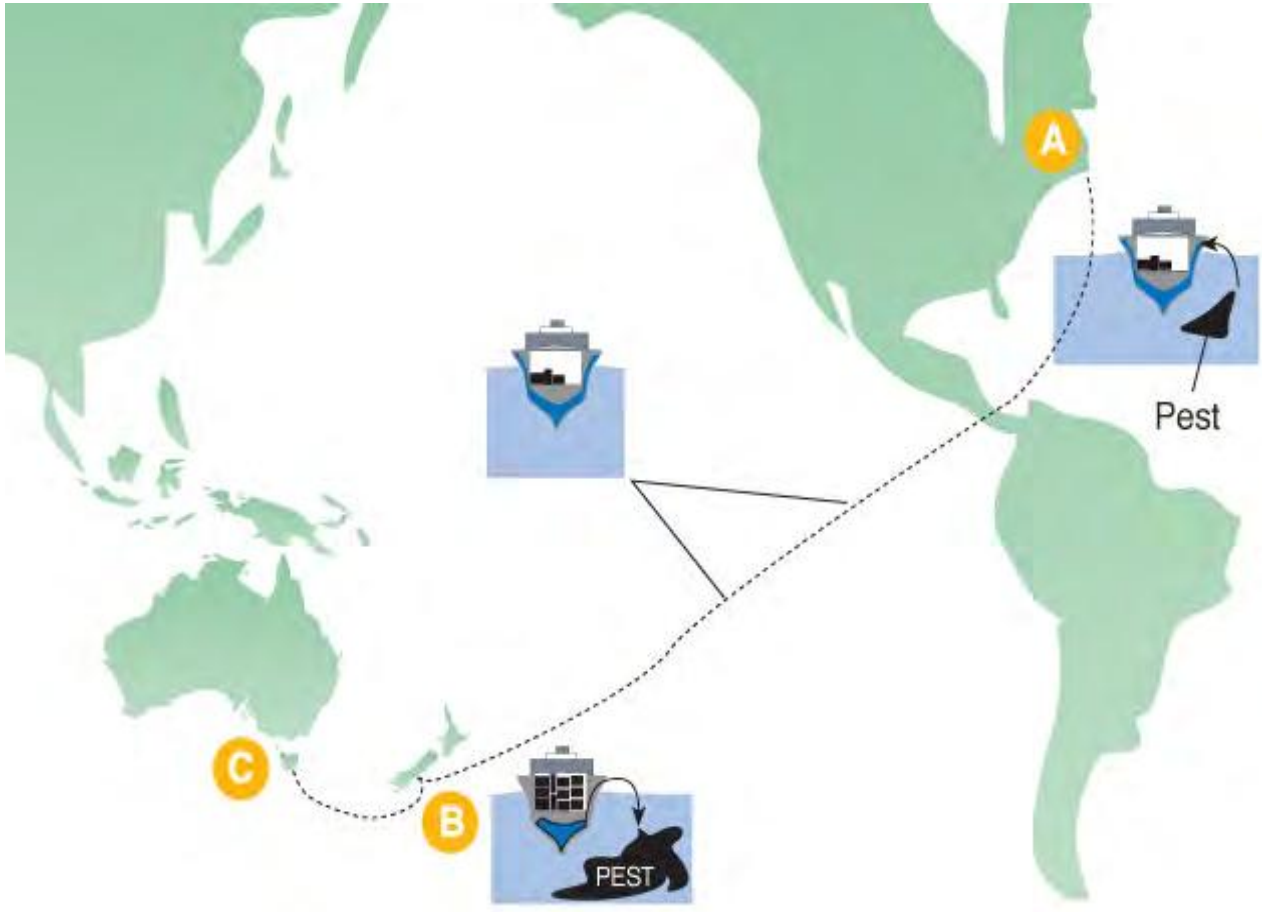


Queensland Fruit Quarantine sign

Photo Queensland Government

© Wet Paper Publications

But in the sea, marine pests can spread from country to country in water carried by ships.



Marine pest transport

Illustration Bob Moffatt Japanese sea star pestPhoto Mike Sugden



Japanese sea star pest

Photo Mike Sugden

© Wet Paper Publications

The largest animals in the world are found in the sea.

This is because sea water can support a greater weight, therefore sea creatures have a completely different skeleton.



Whale

Illustration Kerry Kitzelman

© Wet Paper Publications

Terrestrial animals have hollow bones to keep their weight to a minimum.





Femur of cat

Photo Bob Moffatt Illustration By Sunshineconnelly at en.wikibooks [CC BY 3.0 (http://creativecommons.org/licenses/by/3.0)], from Wikimedia Commons

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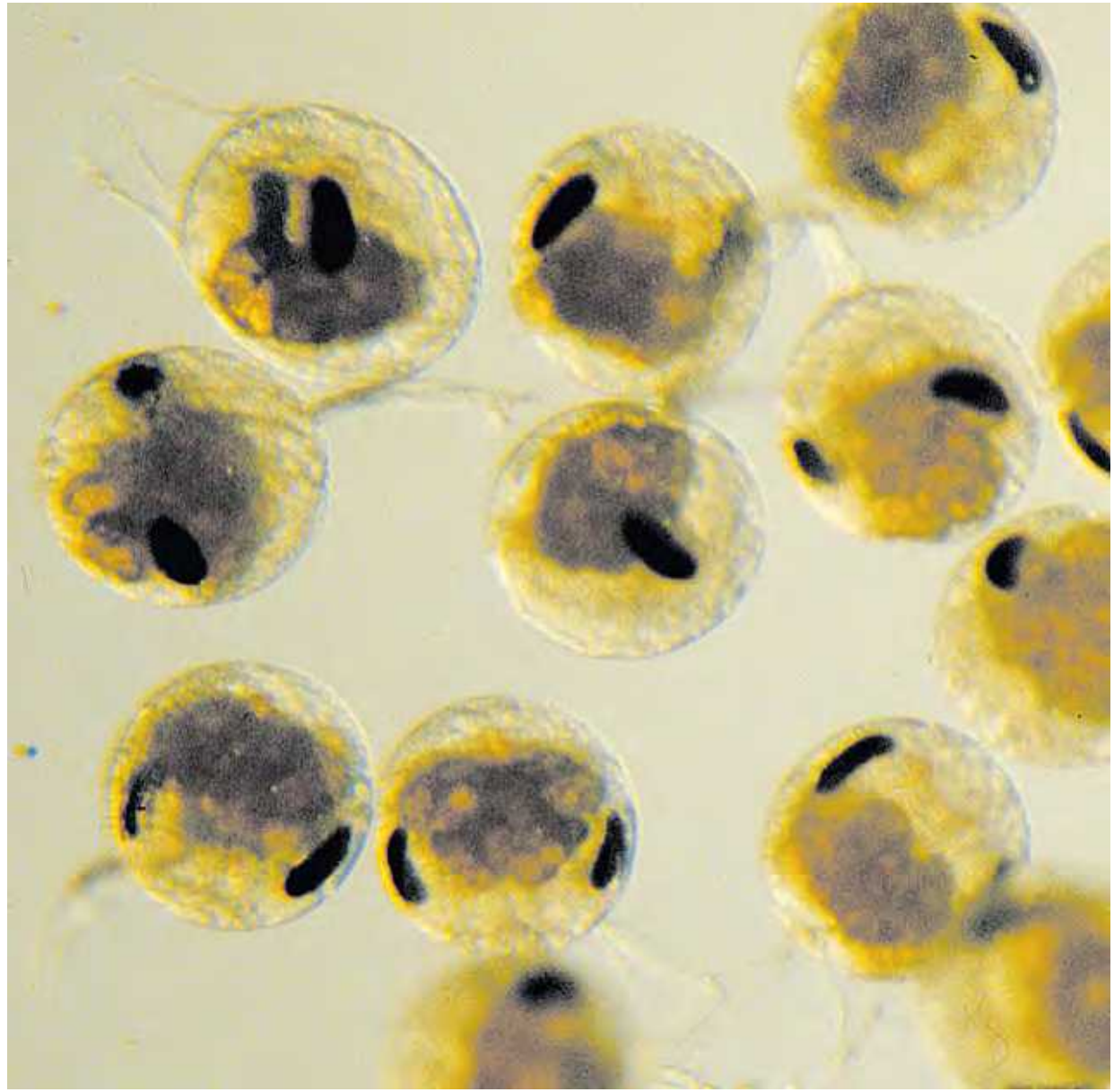
Whereas, aquatic animals mostly have solid bones because the upthrust of the water reduces the impact of gravity on their weight.



Whale skeleton and Gentoo penguins
Photo Bob Moffatt

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Water allows eggs and sperm to fertilise easier and development in the sea. Downsize, mortality of reproductive effort is very high.



Crab eggs
Photo Fisheries Queensland

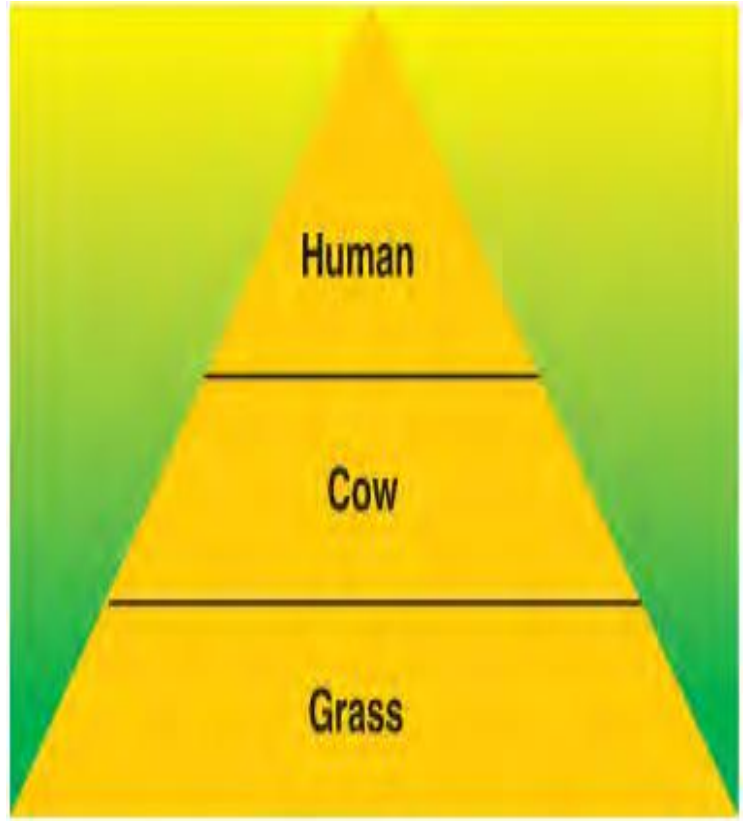
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Water allows higher biomass to increase at higher trophic levels.

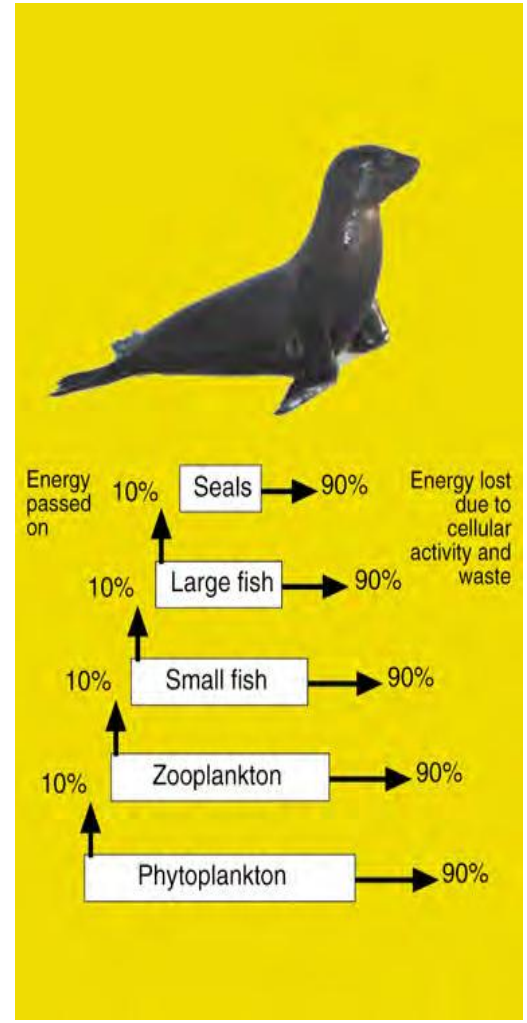
You can read more at

https://en.wikipedia.org/wiki/Biomass_(ecology)

Air restricts food pyramid biomass at the top.



Land food pyramid
Illustration Bob Moffatt



Marine food pyramid
Illustration Bob Moffatt

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You need to become familiar with the idea that:

Marine ecosystems are influenced and limited

by abiotic factors in ways that may be

different from terrestrial ecosystems

due to the

different physical and chemical properties of water compared to air.

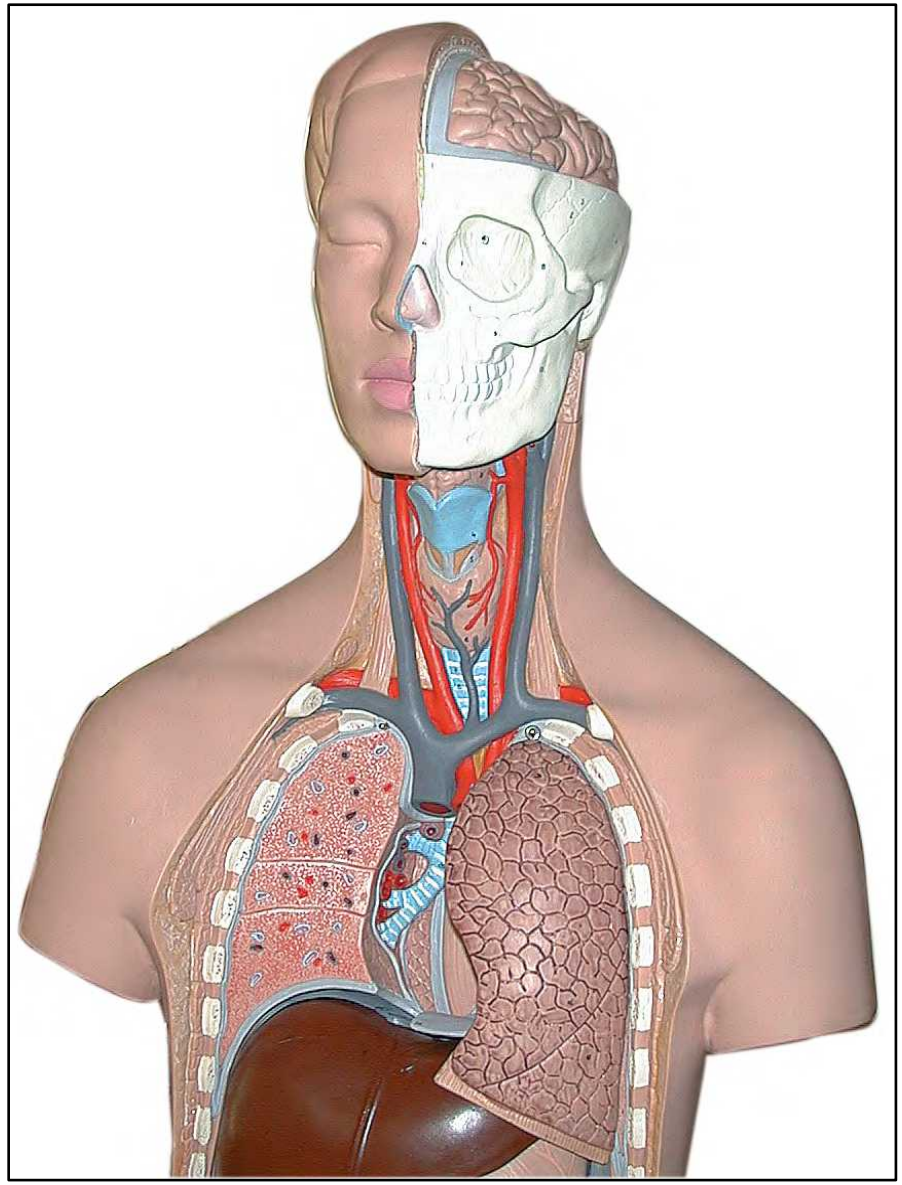
So how is water so different from air in affecting life in the sea?



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For land vertebrates, atmospheric oxygen enters the blood through lungs.

Lungs are supported internally by cartilage and tissue and we can go most places and breathe normally.



Human lungs
Photo Bob Moffatt



Human skeleton
Photo Amazon.com

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Just like us fish need oxygen to live but water has a different molecular structure.

A piece of cloth (just like gills) spreads out in water quite well, but take it out and it collapses.



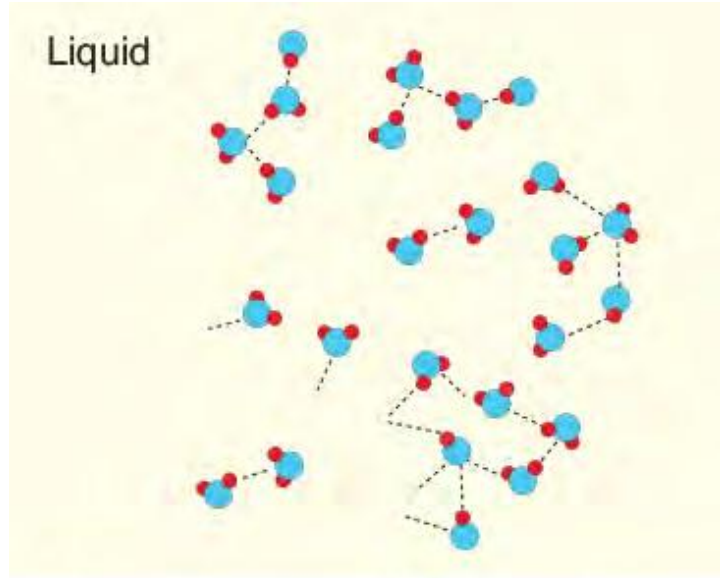
Gills and cloth demonstration

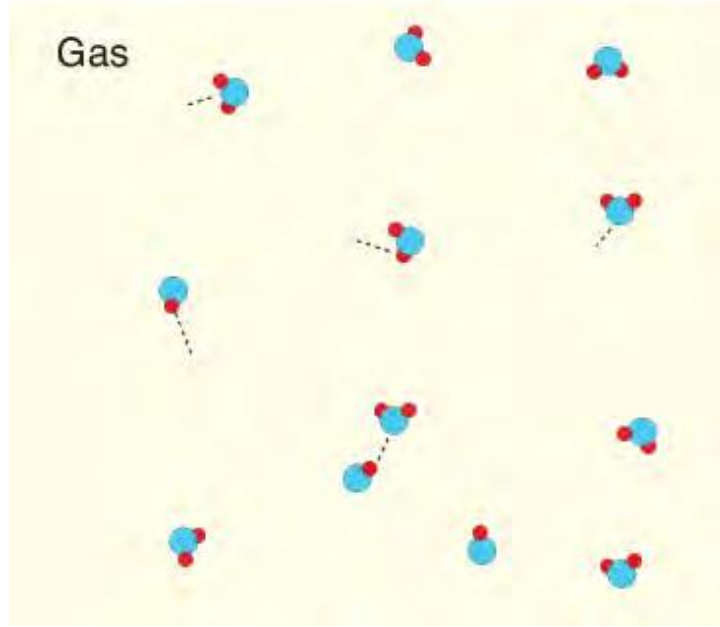
Photo Bob Moffatt

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In air, molecules are further apart and so need structures such as lungs to support respiration.

In water, less support is required and so animals and plants respire by gills and plants do not need woody tree trunks to support processes such as photosynthesis.

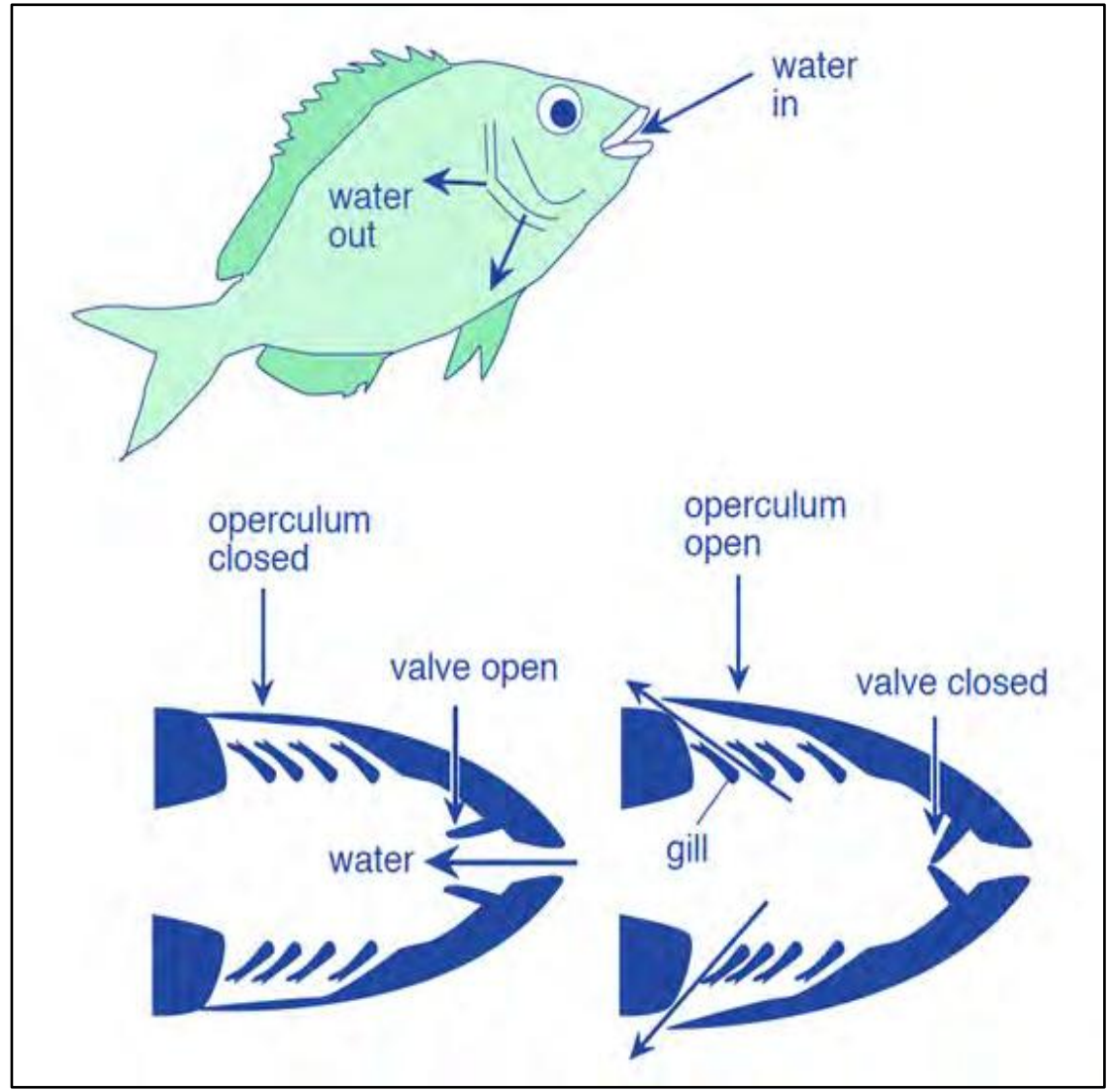




Bob Moffatt

© Wet Paper Publications

Fish have gills and their structure is much different than lungs, as it has minimal internal structural support.



Gills fish and operculum
Illustration Bob Moffatt

© Wet Paper Publications

Water and air have great differences when it comes to respiration

Comparision of water and air as a respiratory medium	Air	Water
Density	1	1000
Viscosity	1	100
Oxygen content	21%	.8%
Diffusion rate	10,000	1

Air and water comparison for respiration

Illustration Bob Moffatt

© Wet Paper Publications

Our eyes are designed for us to see long distances in air and our eyes are encased on a skull which directs them forward preventing us from seeing in all directions.



Eyes in air look to distance

Photo Bob Moffatt



Human skull

By Sklmsta (Own work) [CC0], via Wikimedia Commons

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But the distance light can travel in water is greatly reduced and marine life needs to see in all directions.

We compensate not being able to see in all directions with the use of other highly developed sensory systems e.g hearing.

So we need to wear a face mask to provide that air space for us to see clearly underwater.



Face and mask

Photo Underwater Rhelms

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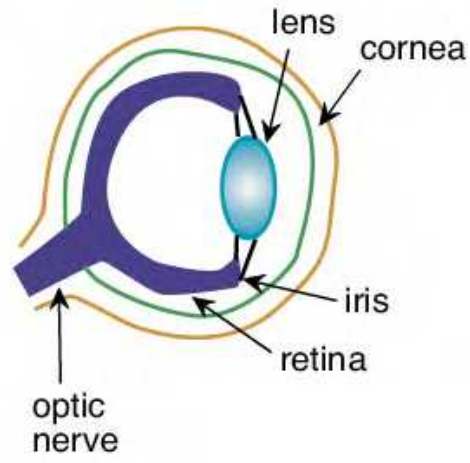
The eye of the fish varies from the eye of land mammals in that the lens does not change shape but changes position.

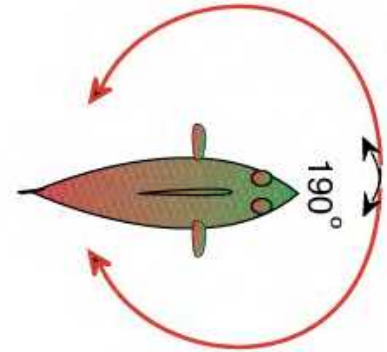
The lens moves in and out to focus rather than change shape as it does in humans.



Puffer fish
Photo Mike Sugden







Fish eye and vision
Photo Underwater helms, Illustration Bob Moffatt

© Wet Paper Publications

The eyes of the mantis shrimp are mounted on mobile stalks and can move independently of each other. Mantis shrimp are thought to have the most complex eyes in the animal kingdom and have the most complex visual system ever discovered e.g they can see ultraviolet light.



Mantis Shrimp Eyes

By Alexander Vasenin - Own work, CC BY-SA 3.0, https://commons.wikimedia.org/w/index.php?curid=61329898

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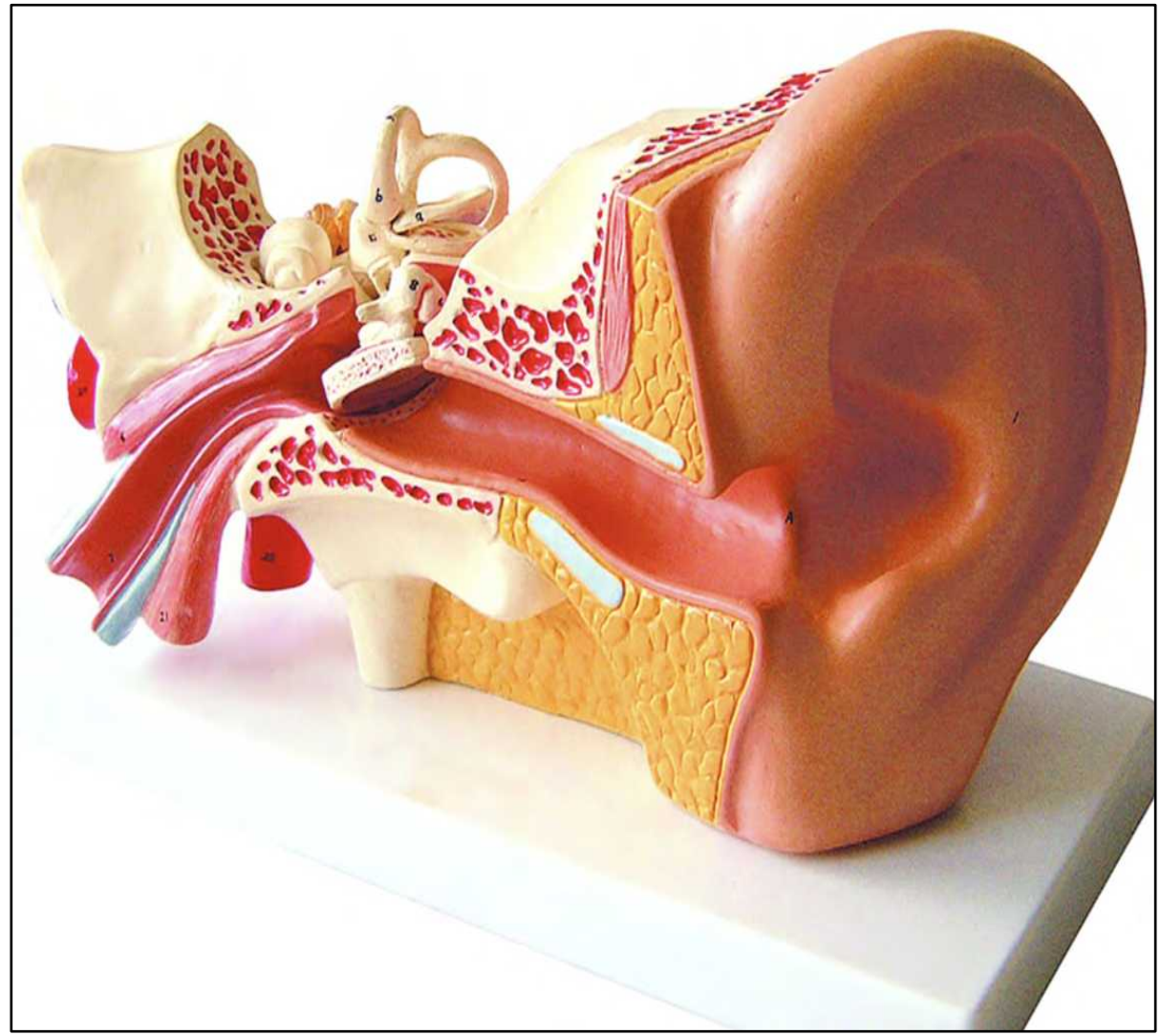
The mantis shrimp can strike by rapidly unfolding and swinging their raptorial claws at the prey, and can inflict serious damage on victims significantly greater in size than themselves. These two weapons are employed with blinding quickness, with an acceleration of 10,400 g (102,000 m/s2) and speeds of 23 m/s (83 km/h) from a standing start.



By Roy L. Caldwell, Department of Integrative Biology, University of California, Berkeley - National Science Foundation [1], Public Domain, https://commons.wikimedia.org/w/index.php?curid=10483908

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Land vertebrates hear by way of membranes that vibrate in their ears as sound waves enter.



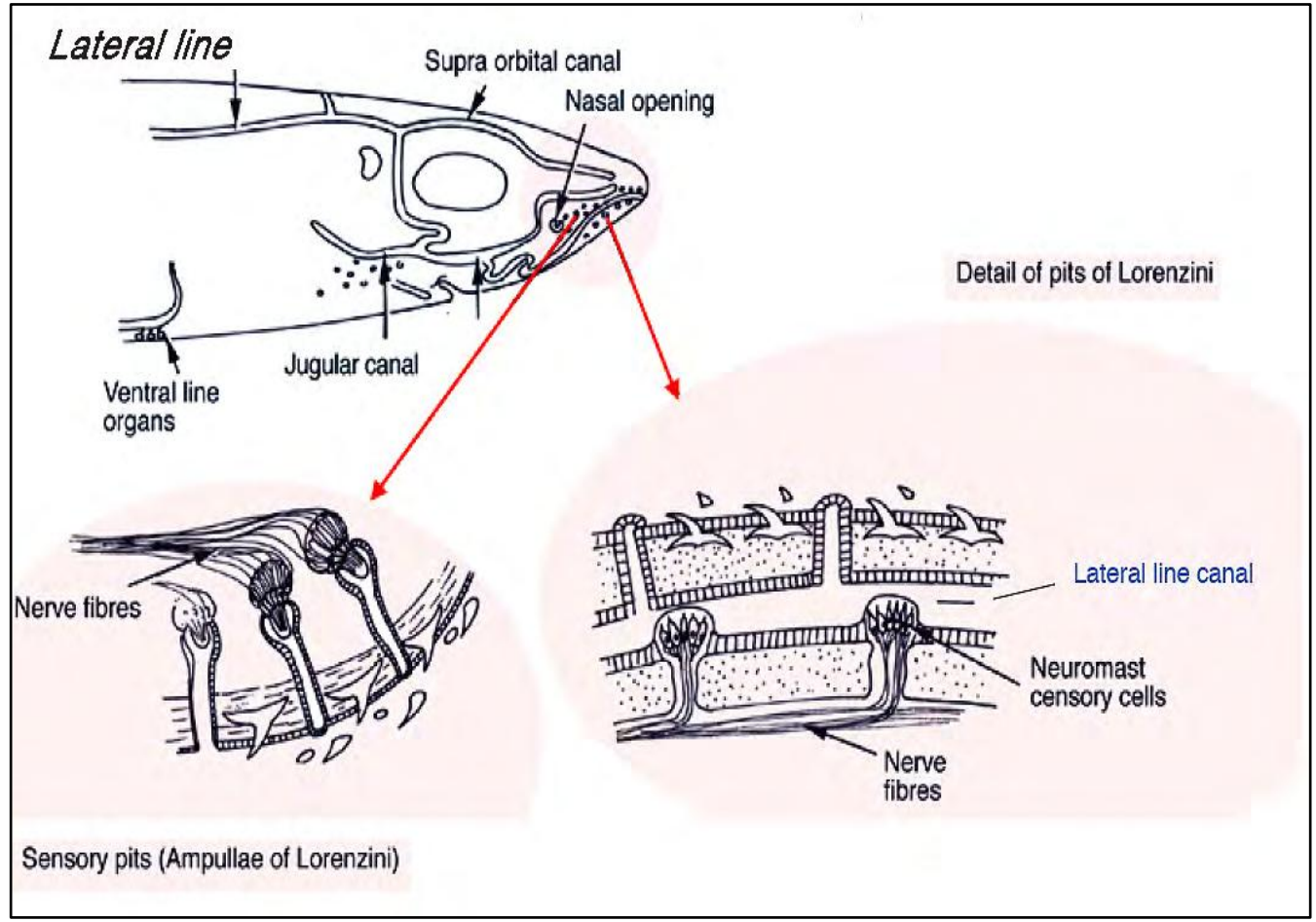
Model ear

https://www.tts-group.co.uk/4x-life-size-human-ear-model/1003811.html

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Water creates a different set of abiotic factors to which physiological solutions have had to be made.

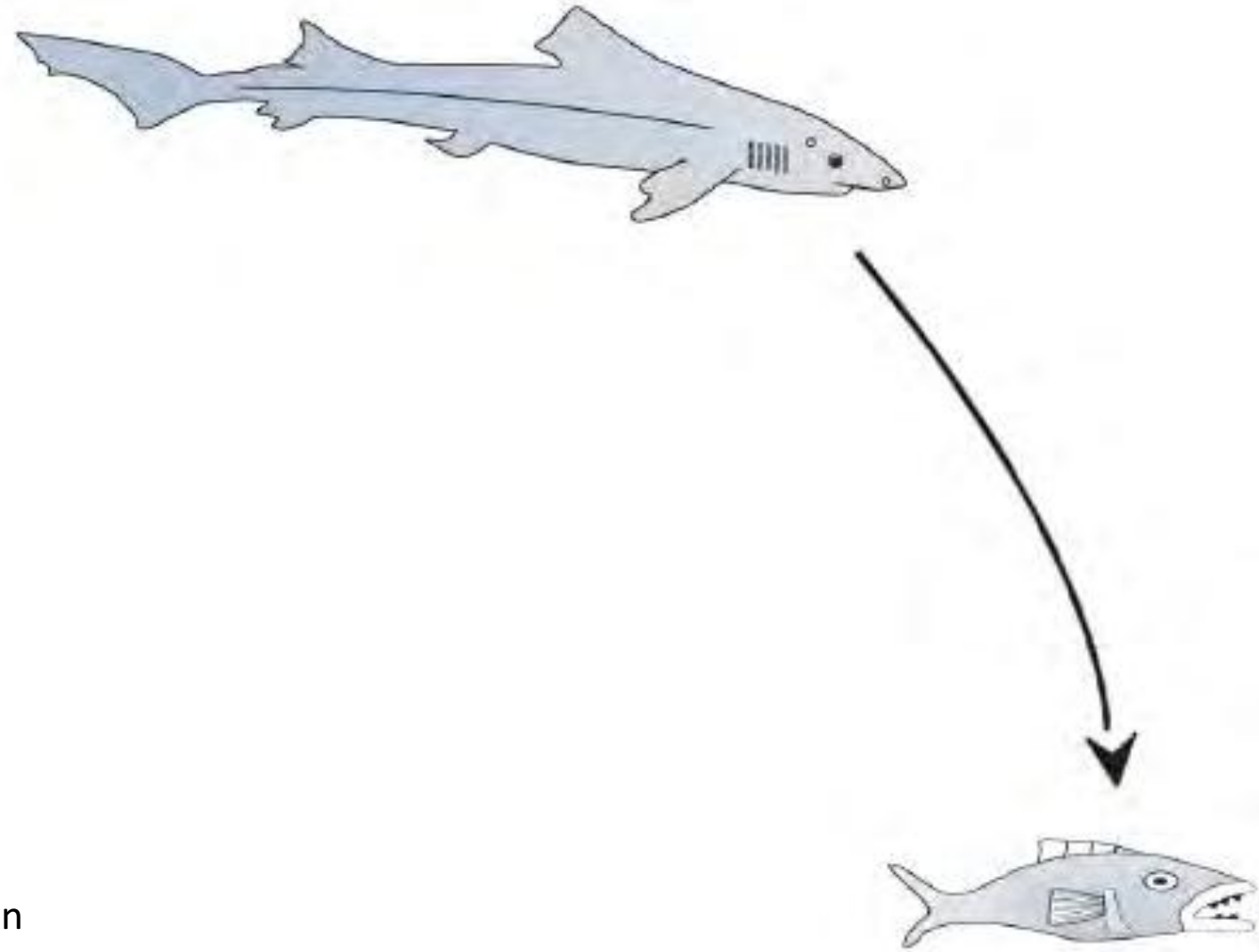
Sharks use sensory pits with their lateral line to locate their prey.



Shark lateral line

Illustration Tom Hailstone

© Wet Paper Publications



Shark and fish detection

Illustration Bob Moffatt

© Wet Paper Publications

Plants capture the Sun's energy and use it to make food from raw materials.

Both land and marine plants use carbon dioxide, water, and minerals.

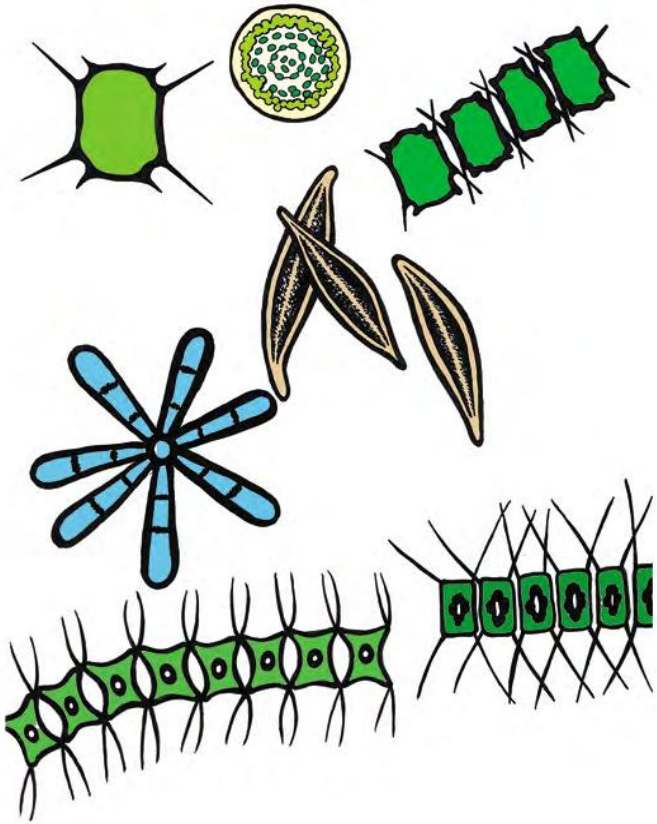
Air allows the gases to be absorbed in the land plants leaves which in turn are held up by a woody trunk and stem. Vessels transport the nutrients to parts of the plant where needed.

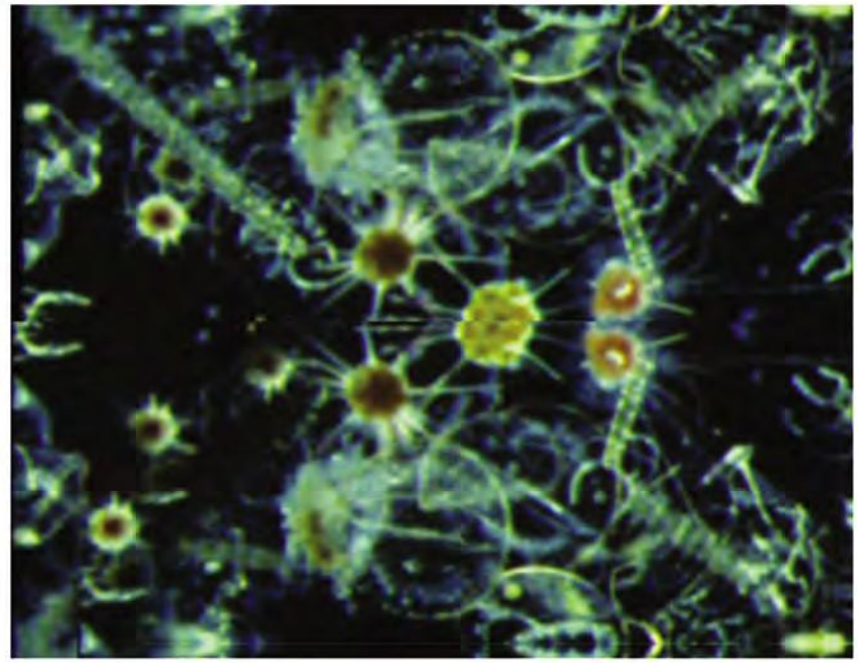


Figure Gum tree
Photo Bob Moffatt

© Wet Paper Publications

Water contains nutrients and dissolved gases so marine plants do not need vascular tissue to accommodate photosynthesis or to carry its products to each cell.





Phytoplankton

Photo Jack Marsh
Illustration Sharyn Madder

© Wet Paper Publications

In addition, marine plants do not need support structures because they are held up by the buoyant force of the water.



Marine algae
Photo Mike Sugden

© Wet Paper Publications

Since water in the ocean is always moving, the bodies of marine plants are flexible, permitting them to go with that movement.

Some marine plants secrete a holdfast to keep them in one place.



Algae and holdfast
Photo Bob Moffatt

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Additional web references

https://courses.lumenlearning.com/boundless-biology/chapter/aquatic-biomes/



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Certificate of understanding hereby awarded to

for becoming familiar with the idea that

Marine ecosystems are influenced and limited by abiotic factors in ways that may be different from terrestrial ecosystems due to the different physical and chemical properties of water compared to air.

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T052 Abiotic factors of marine ecosystems



Bob Moffatt

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Syllabus statement

Warning:
This is really long.

At the end of this topic you should be able to ...

distinguish



abiotic components of marine ecosystems:
Light availability
Depth
Stratification
Temperature
Waves and wind
Currents
Tides
Sediment type
Nutrient availability



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Distinguish

– to recognise as distinct or different;

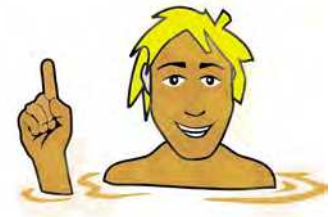
note points of difference between;

discriminate;

discern;

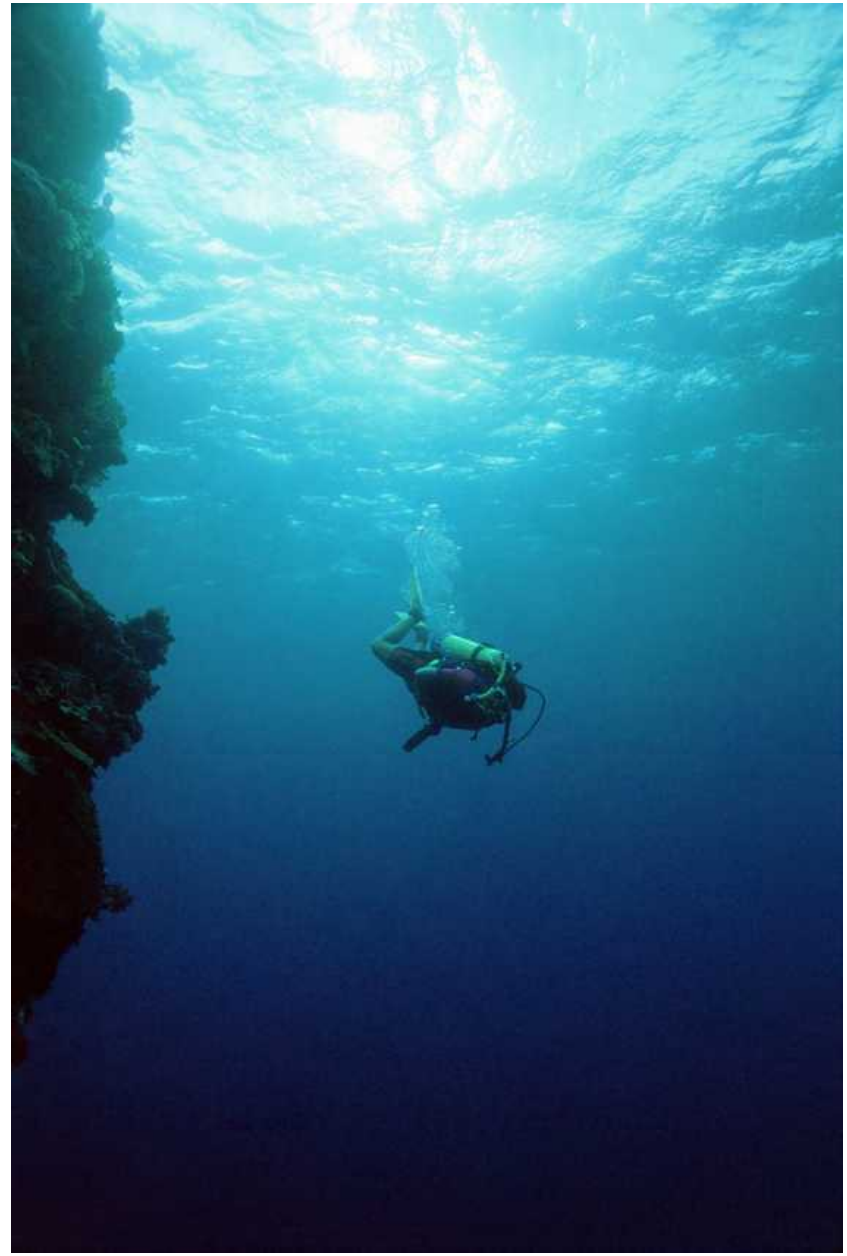
make clear a difference/s between two or more concepts or items





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Light availability



Diver decends to darkness

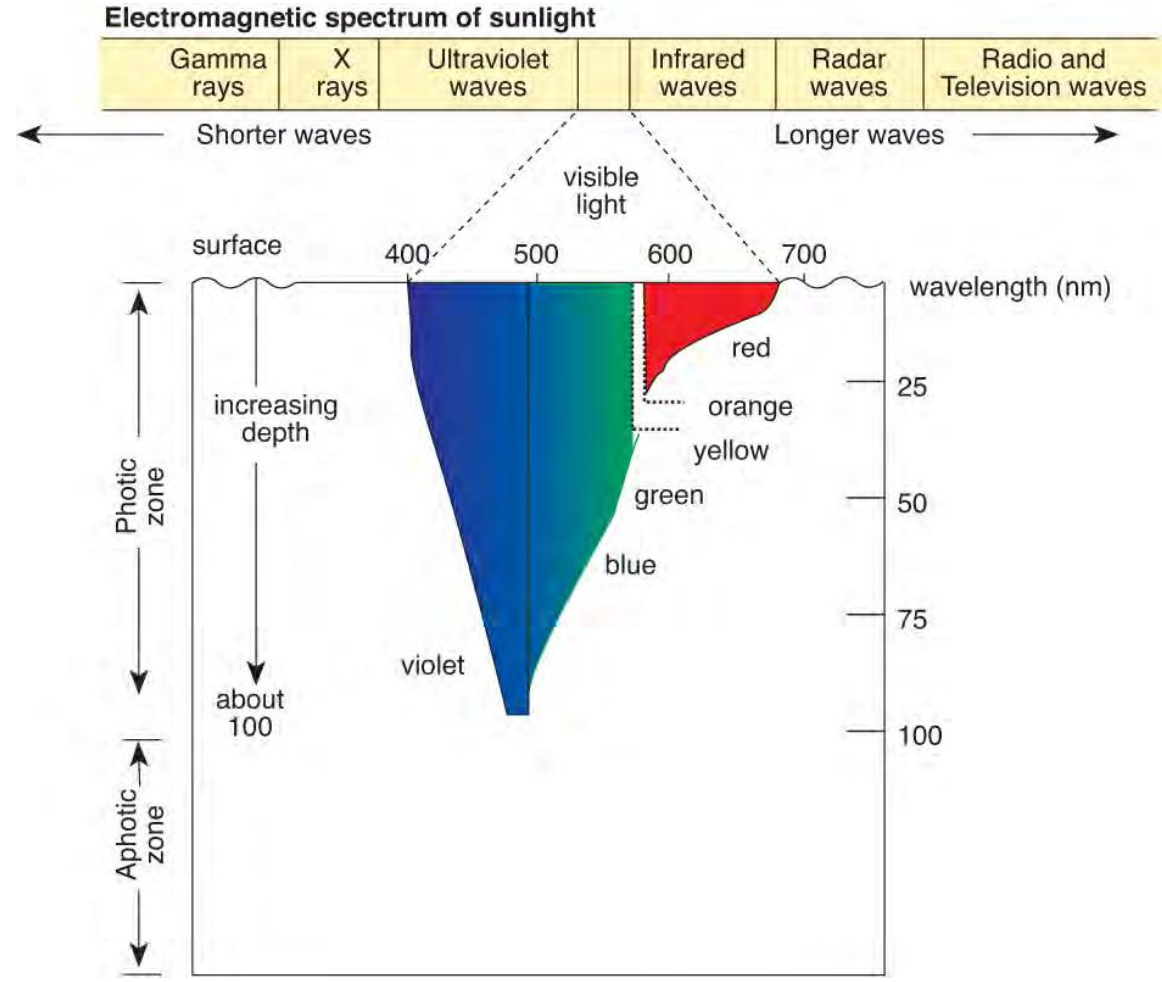
Photo Viewfinder Australia

© Wet Paper Publications

White light is made up of the full spectrum of colours of the rainbow.

Red light is absorbed first by the water and does not penetrate as far as the blue or violet light.

This is because the shorter the wavelength of light, the greater the depth it penetrates.



Light penetration

Illustration Trent Moffatt

© Wet Paper Publications

Since an object will be the colour of light it reflects, a red fish at a depth of 30 m will reflect little red light.

So a red emperor will appear dark at depth.



Red throat emperor and reef scene

By Jean-Lou Justine (Own work) [CC BY-SA 4.0 (https://creativecommons.org/licenses/by-sa/4.0)], via Wikimedia Commons, photoshoped scene by deep voyage

© Wet Paper Publications

But a lot brighter when brought into the air.



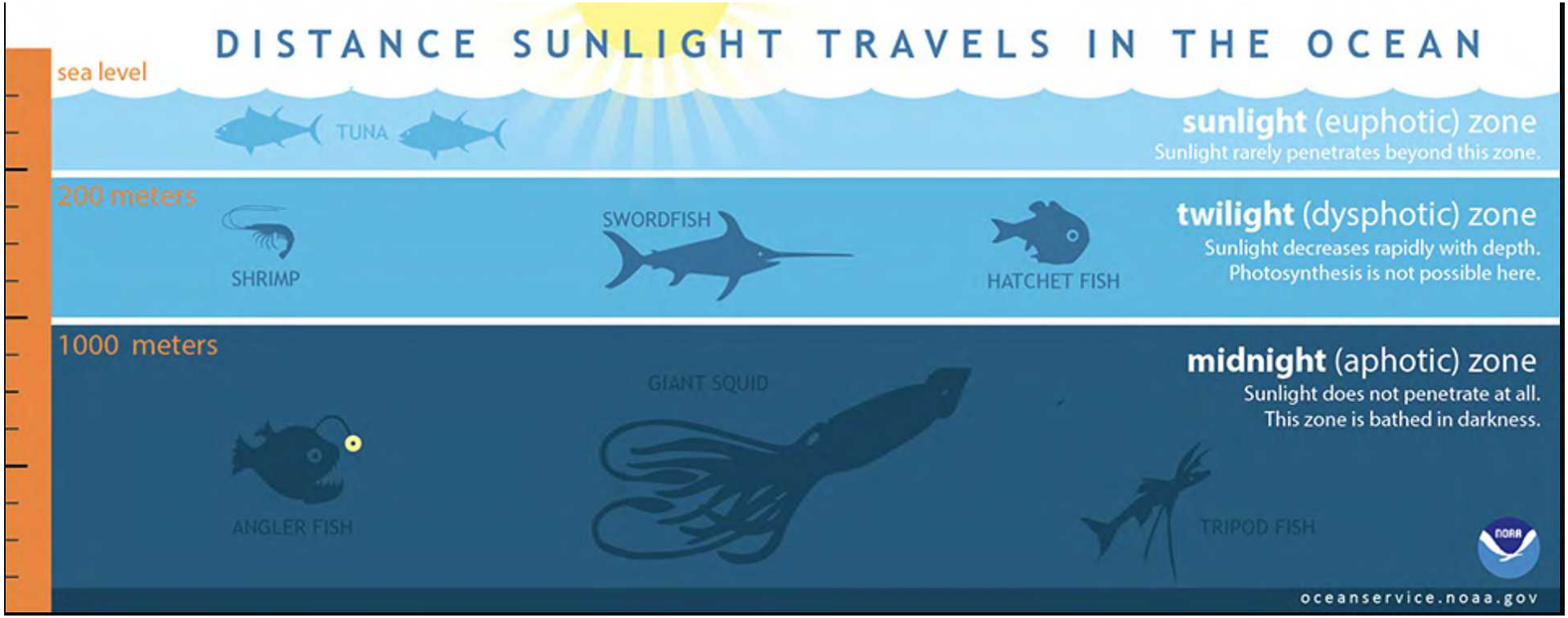
Red throat emperor at surface

By Jean-Lou Justine (Own work) [CC BY-SA 4.0 (https://creativecommons.org/licenses/by-sa/4.0)], via Wikimedia Commons

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The impact is that there is also a limit to the depth to which light can penetrate into the sea (usually the top 100 m of the ocean).

This results in three distinct photic zones with different types of marine life.



Distance light travels in the sea

Citation: NOAA. How far does light travel in the ocean?
National Ocean Service website,https://oceanservice.noaa.gov/facts/light_travel.html

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In the sunlight zone, the amount of light that penetrates the water depends on dissolved minerals, silt and detritus material contained in it.

Blue water indicates that the surface water contains very few minerals and so has little plant life, so it can be considered a ‘desert’ area.

Green sea water contains large concentrations of ions, which in turn cause an abundance of plant growth, which in turn attracts large numbers of animals.



Blue seawater

Photo Viewfinder

You can read more at https://en.wikipedia.org/wiki/Ocean_color

© Wet Paper Publications

Colour can also depend on the amount of suspended matter.

Sand disturbed by breaking waves cause the colour to change.



Colour of water in surf

Photo Bob Moffatt

© Wet Paper Publications

When it rains in cities and coastal towns pollution from the land flows through stormwater pipes and into the sea.

This changes the quality and colour of the water significantly.



Blue Creek water with drains (no rain for a week)
Photo Bob Moffatt

© Wet Paper Publications

Fast flowing rivers can also carry sediment and fertilisers into the sea.

Coupled with wave action and tides, this can reduce light penetration significantly.



Mangroves close to farmland

Photo Bob Moffatt

© Wet Paper Publications

So light availability in the sea is impacted by sediments from the land.



Sediments from the land impact on light availabilty in the sea

Photo Bob Moffatt

© Wet Paper Publications

Light availability also impacts on an animal's vision in the sea.

Most fish have well developed eyes to detect light penetrating the water.



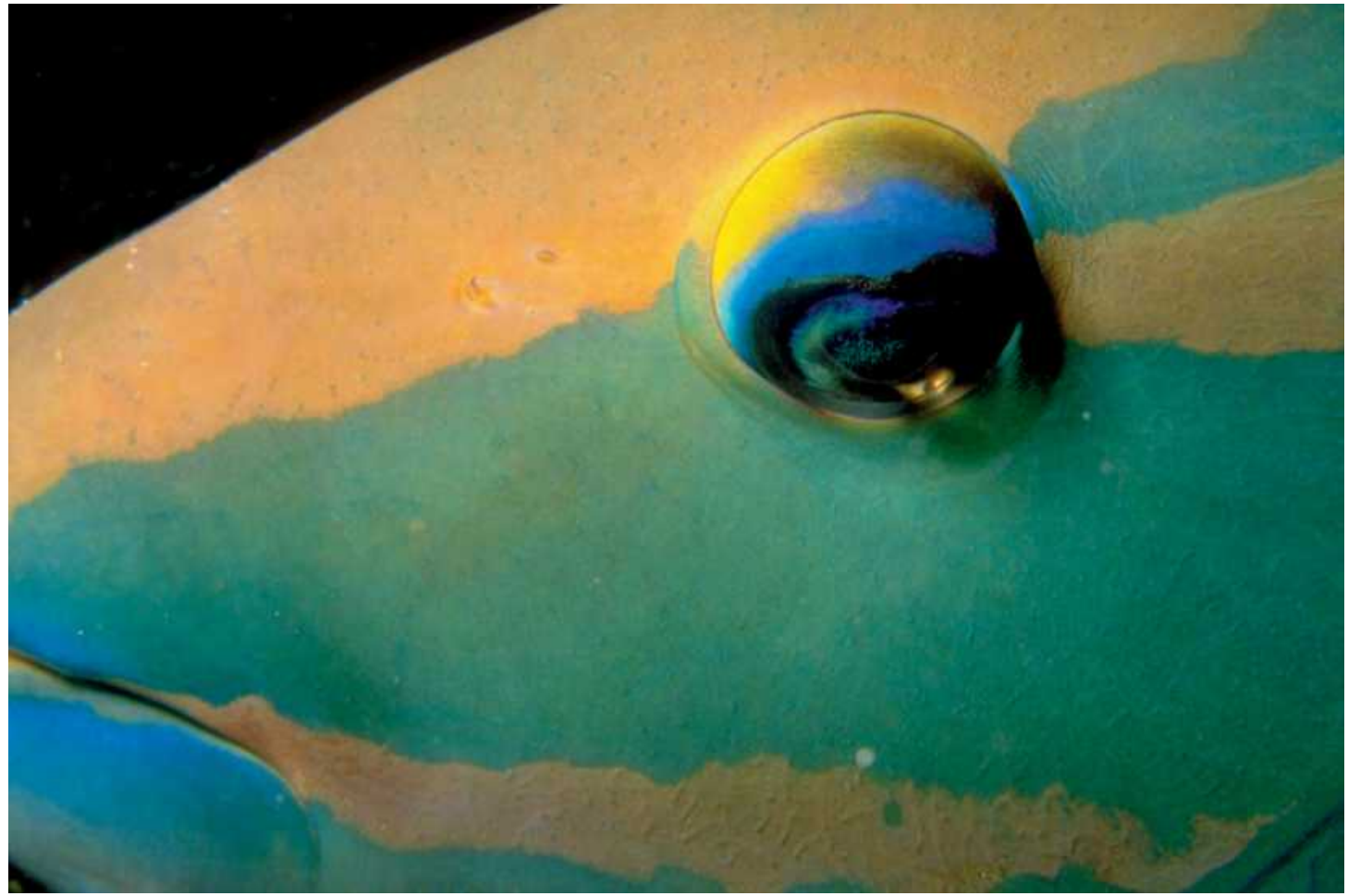
Blue eye fish

Photo Fisheries Queensland

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The lens of the eye of the fish is spherical and protrudes out of the iris, giving the fish a good peripheral vision.

It is possible for the light to enter the eye from wide angles. This allows the fish to have nearly 360° or total field of view.

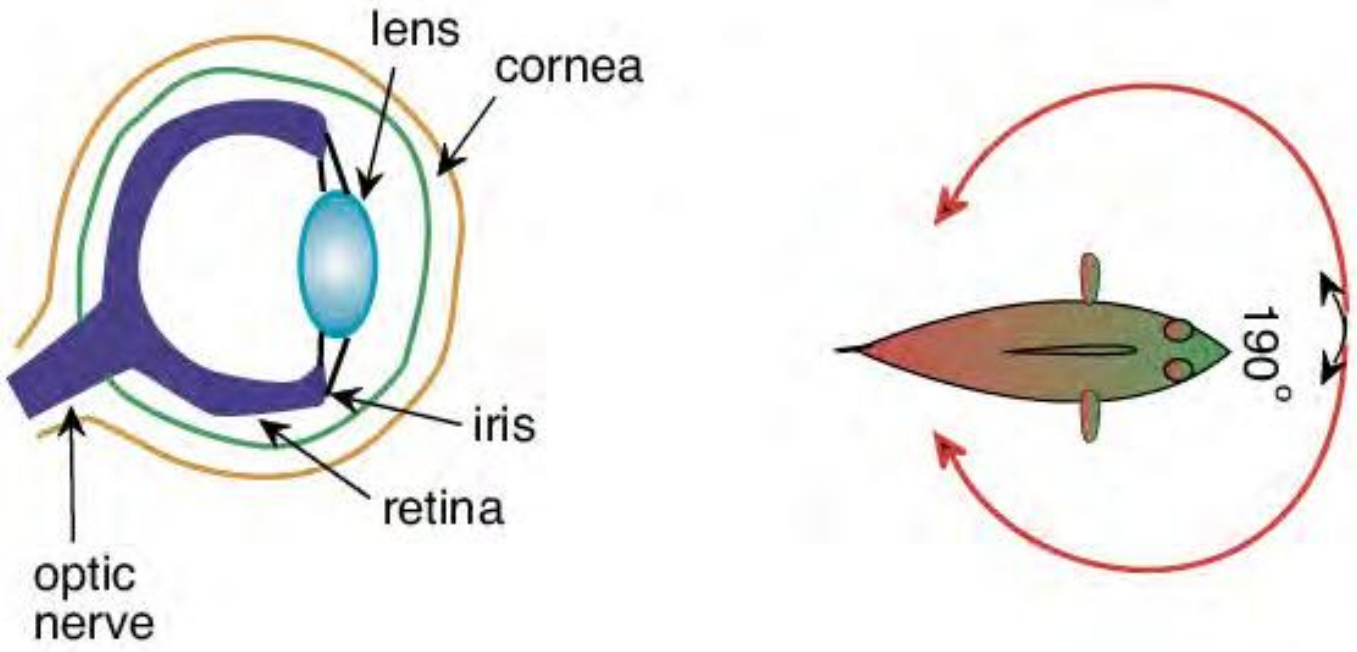


Fish eye

Photo Underwater Rhelms

© Wet Paper Publications

This is especially helpful for fish because the prey or the predators can be seen above, below, in front of or behind their body.



Fish eye and vision

Illustration Bob Moffatt

© Wet Paper Publications

Light availability also impacts on reproduction.

Fish must be able to see colour and patterns because of their own colouration and courtship behaviour.



Zebrafish

By Azul (Own work) [Copyrighted free use], via Wikimedia Commons

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In the midnight zone fish can only detect the intensity of the light or the light from other sea creatures.

Their eyes are well developed with a large pupil and a special golden pigment that is sensitive to blue light.

Some of the species found in the deep have tubular eyes that can concentrate or better focus the light.



Viperfish

By Forgerz (Own work) [CC BY-SA 3.0 (https://creativecommons.org/licenses/by-sa/3.0)], via Wikimedia Commons
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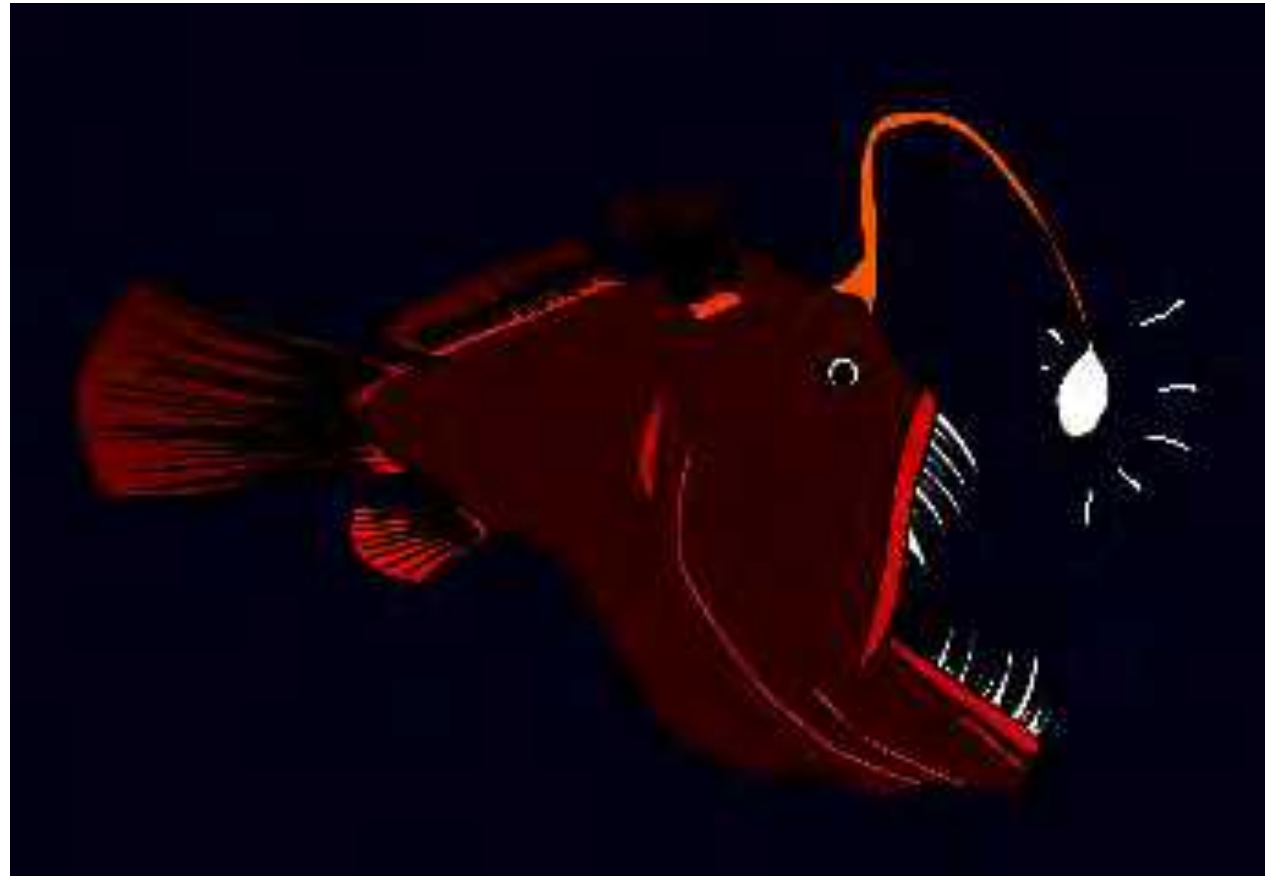
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Fish that live below 1000 m have small eyes or no eyes.

The exception being the Lantern fish which uses its eyes to find its mate.

The male anglerfish has an organ that can produce light to attract the female.

There are over 600 different species of fish living below 1000 m that possess light producing organs.

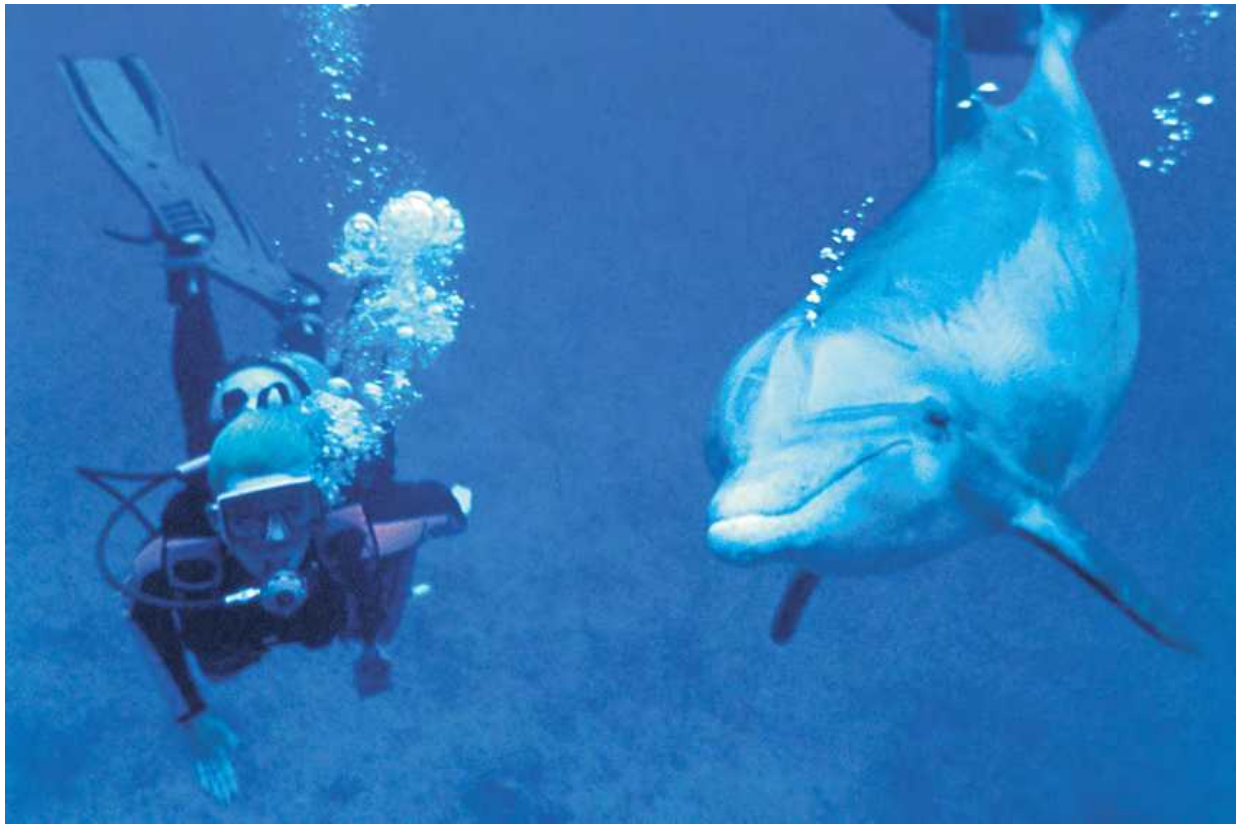


Lantern fish

Illustration Kerry Kitzelman

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Depth

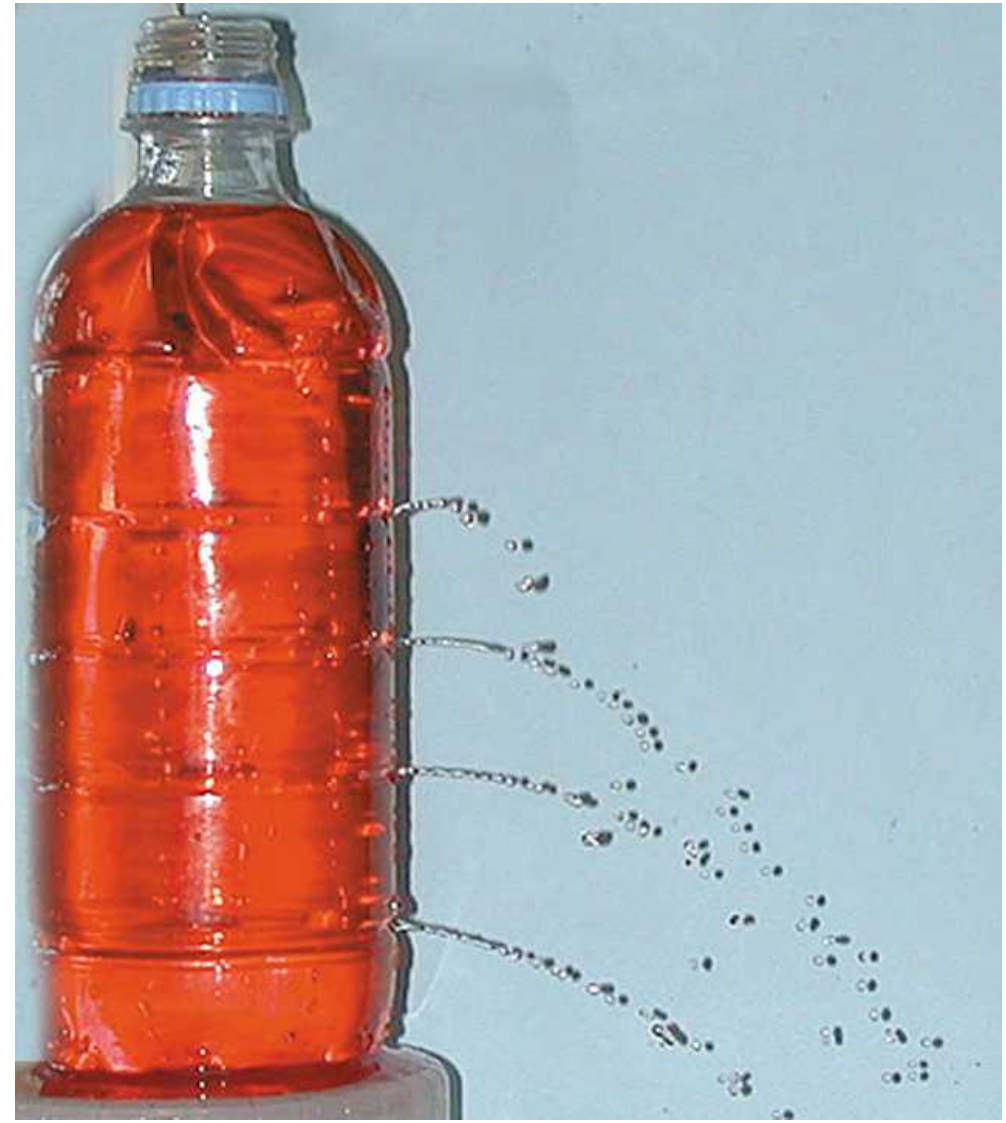


Dolphin and diver
Photo Neville Coleman

Web Reference
https://oceanservice.noaa.gov/facts/pressure.html

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Pressure increases with depth as seen in a simple experiment with a bottle as shown.



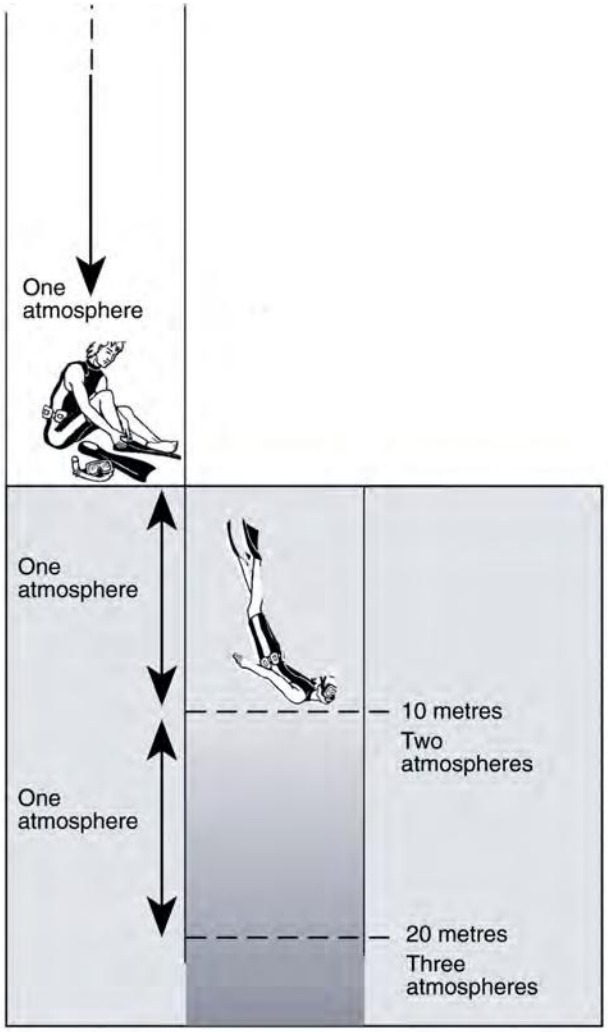
Pressure and depth in a bottle

Photo Bob Moffatt

© Wet Paper Publications

Marine scientists need to be aware of this increase as they dive to study marine biology.

Pressure at the surface is 1 atmosphere but triples at 20 metres to 3 atmospheres.



Pressure and depth on a diver

Illustration Bob Moffatt

© Wet Paper Publications

Pressure impacts on sea creatures such as jellyfish who have to adjust the pressure in their tissues to that of the water outside their body.

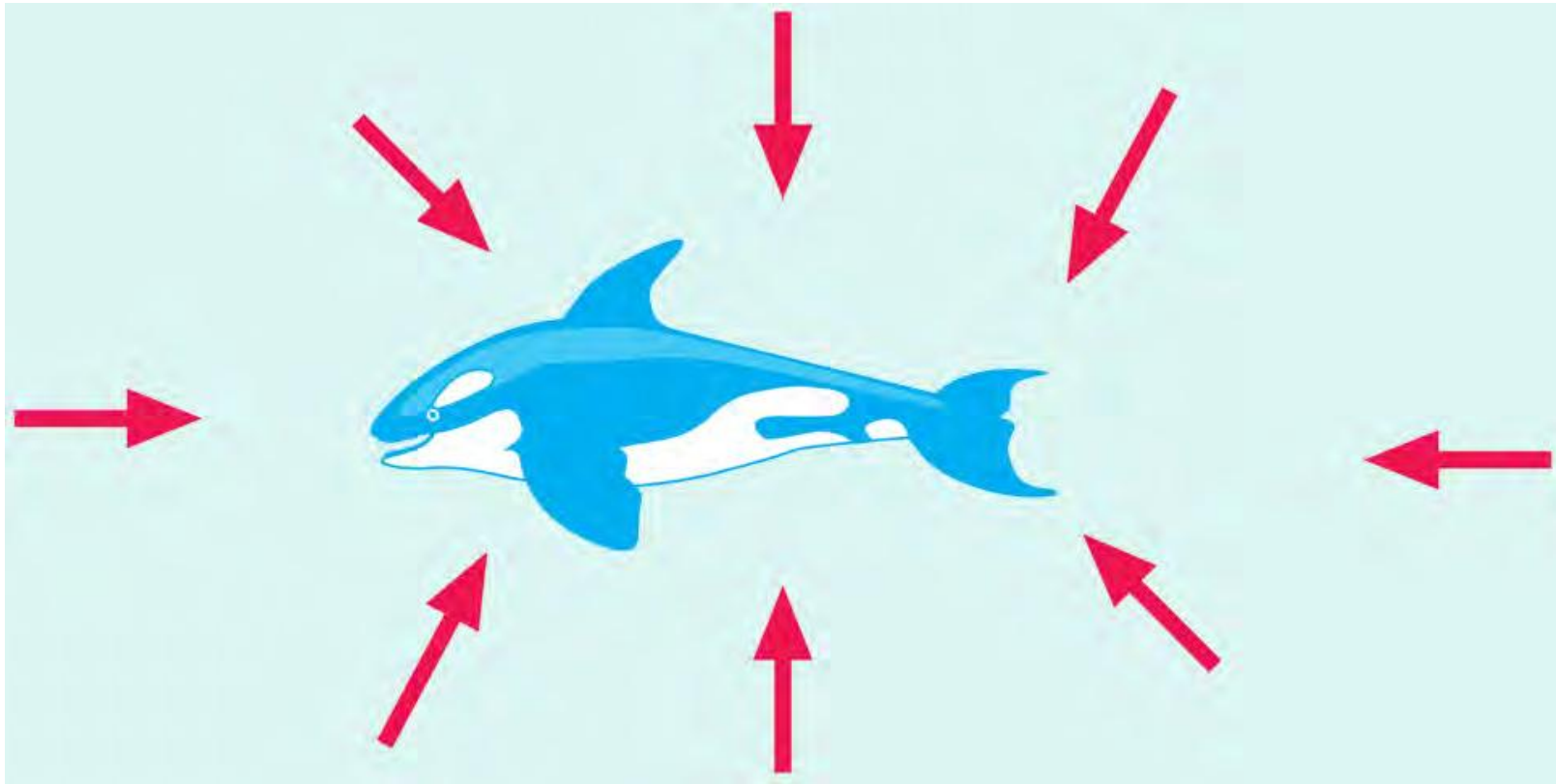


Sea jelly
Photo Bob Moffatt

© Wet Paper Publications

Fish and whales of the great depths have very dense bony bodies and lack air-bladders to cope with pressure changes as they hunt for food at a range of depths.

There was a whale that dives for three kilometres.



Pressure on a whale

Illustration Bob Moffatt

© Wet Paper Publications

Whales have special adaptations to allow them to dive to great depths.

They have lungs and because these will collapse at great depths, they have a special network of blood vessels that carry extra oxygen.

They also have fatty emulsions that carry extra oxygen.



Whale echolocation

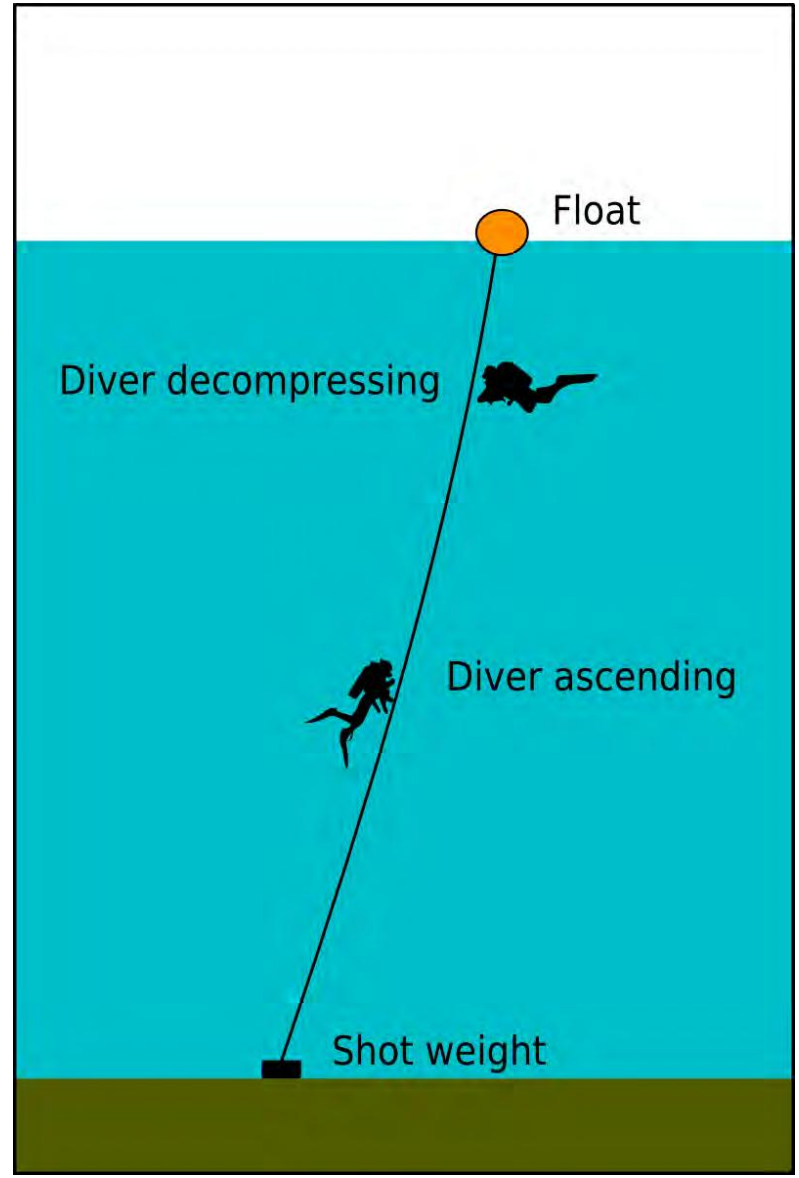
Illustration Steven Byers

© Wet Paper Publications

These same fatty emulsions dissolve nitrogen from the blood stream under pressure at depth.

This impacts on marine scientists who have to allow time when ascending from depth to stop dissolved nitrogen turning to gas bubbles, leaving tissue and blood blocking blood vessels

– this is decompression sickness or commonly known as the ‘bends’. If the diver spends time ascending the nitrogen can be breathed out from the lungs as per normal.



Diver ascending and decompressing

By Peter Southwood (Own work) [CC BY-SA 3.0 (https://creativecommons.org/licenses/by-sa/3.0)], via Wikimedia Commons

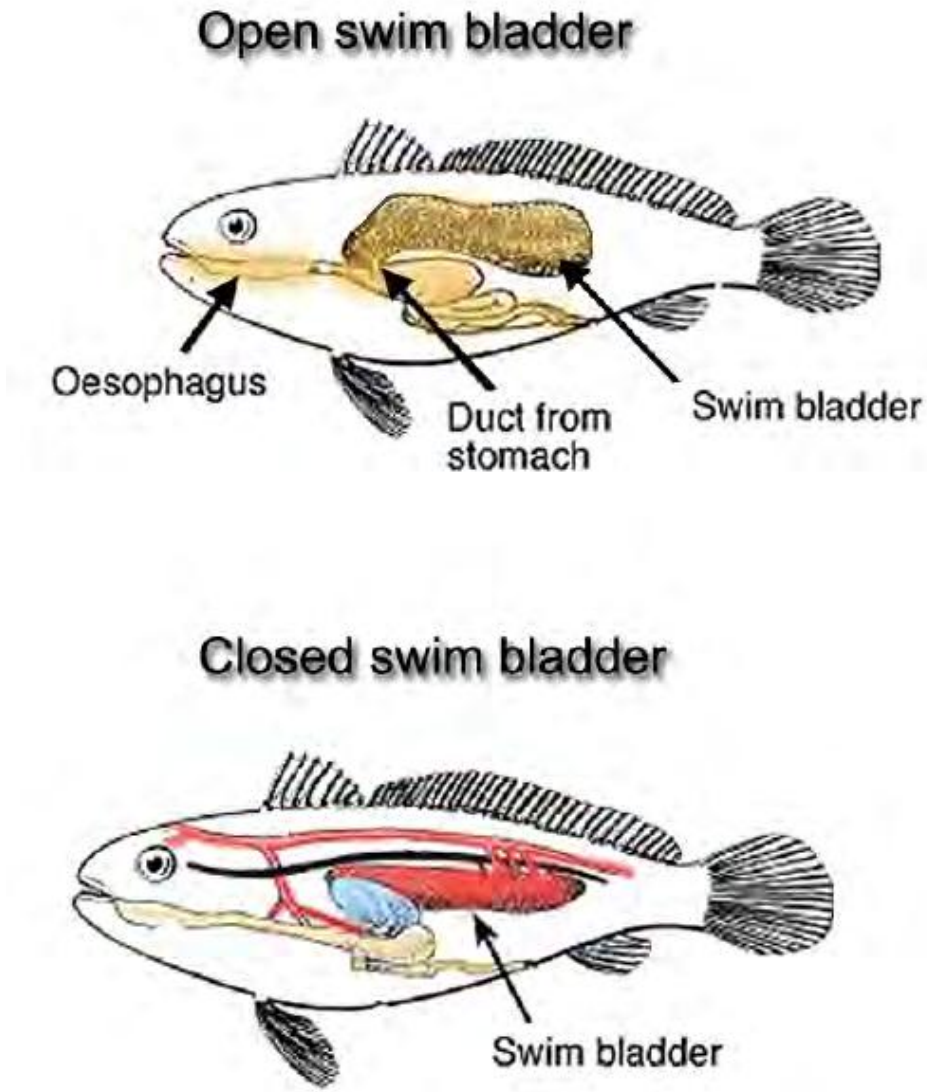
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Depth and density

Since density increases with depth, fish tend to float back to a depth where its density equals that of the water.

They have developed a swim bladder to move through different depths to hunt for food or escape prey.

Sharks have a fatty liver to do this.



Fish swim bladder open and closed

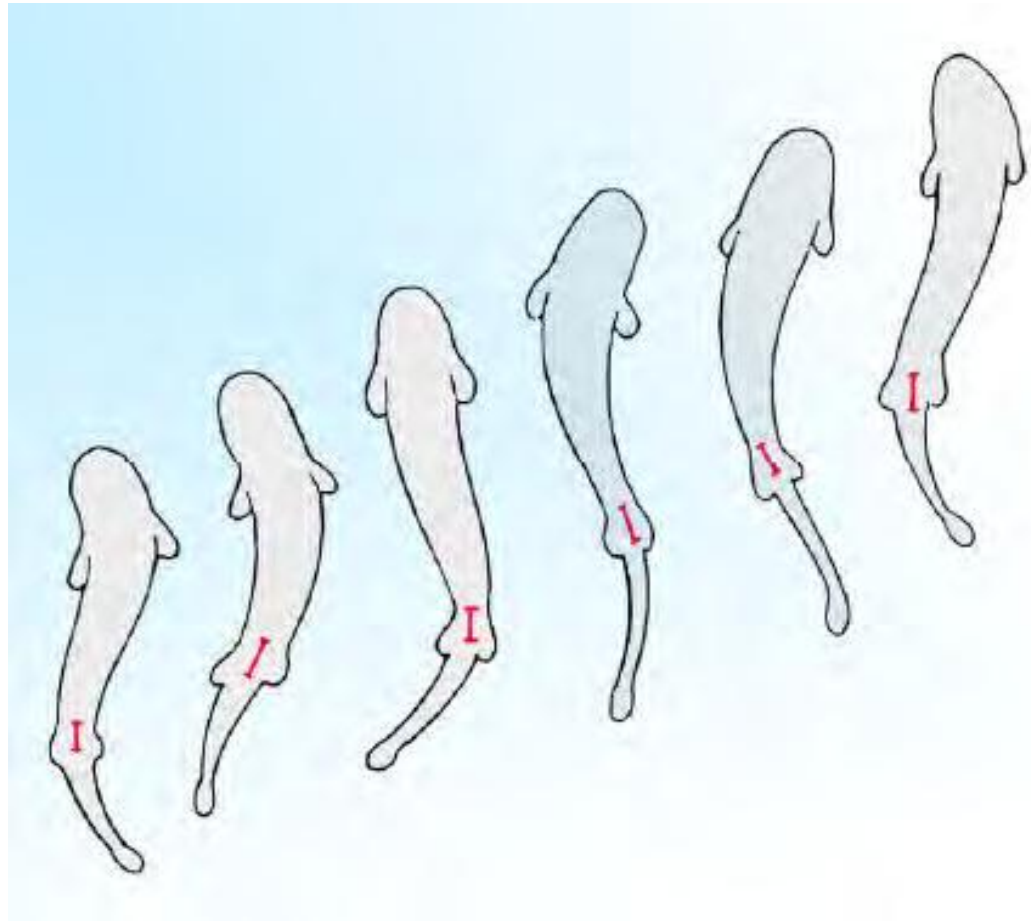
Illustration Jack Marsh

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The density of water impacts on the ability of a fish to move.

Aquatic fish also require fewer interlocking structures on the vertebrae of the dorsal backbone.

This allows a greater flexibility of the backbone permitting the wave-like swimming motions that most fish exhibit.



Shark swimming motion

Illustration Bob Moffatt

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Water viscosity

(Although not part of depth)

Animals that swim fast need to be streamlined to counteract the water's viscosity.

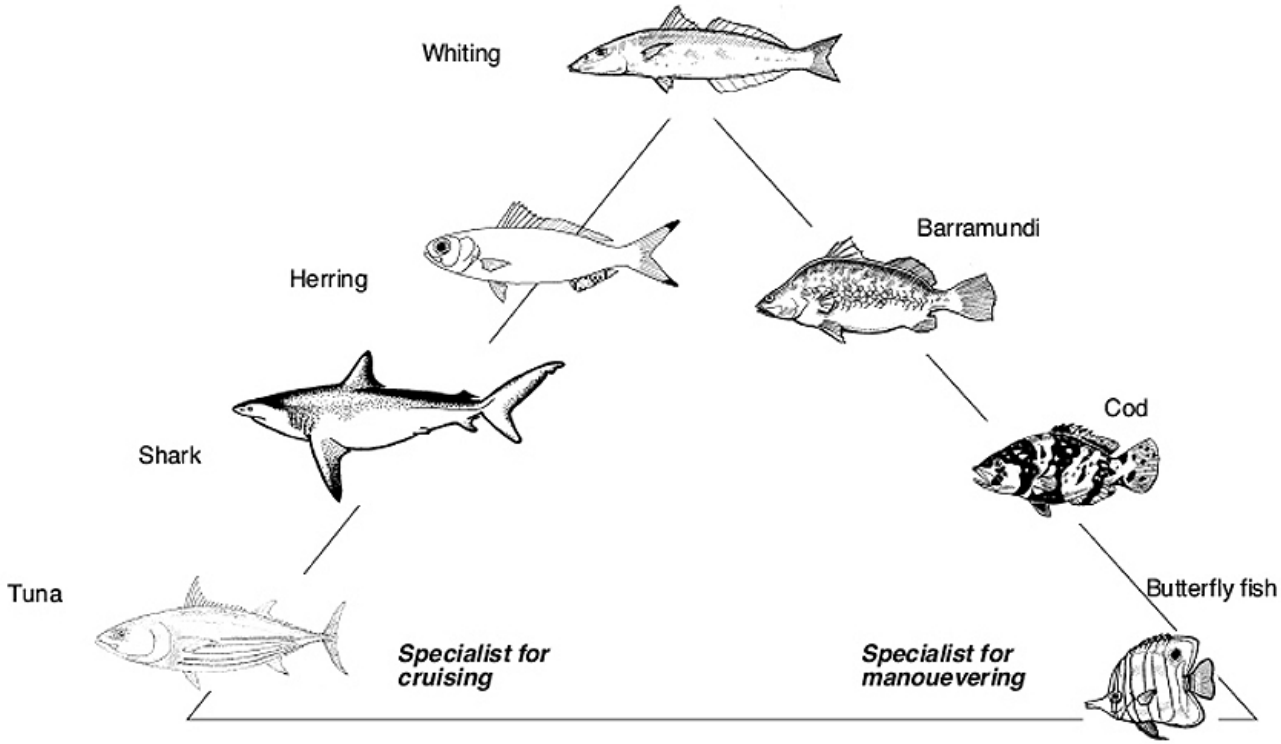


Illustration Wet Paper (After the ideas of Dave Tulip and Jack Marsh)

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Depth impacts on the height of organisms.

Aquatic organisms require fewer supporting structures in their bodies.

An aquatic plant does not require a stem made of tough cells cemented together to hold it upright.

The brown kelp in the photo remains upright while suspended in water.

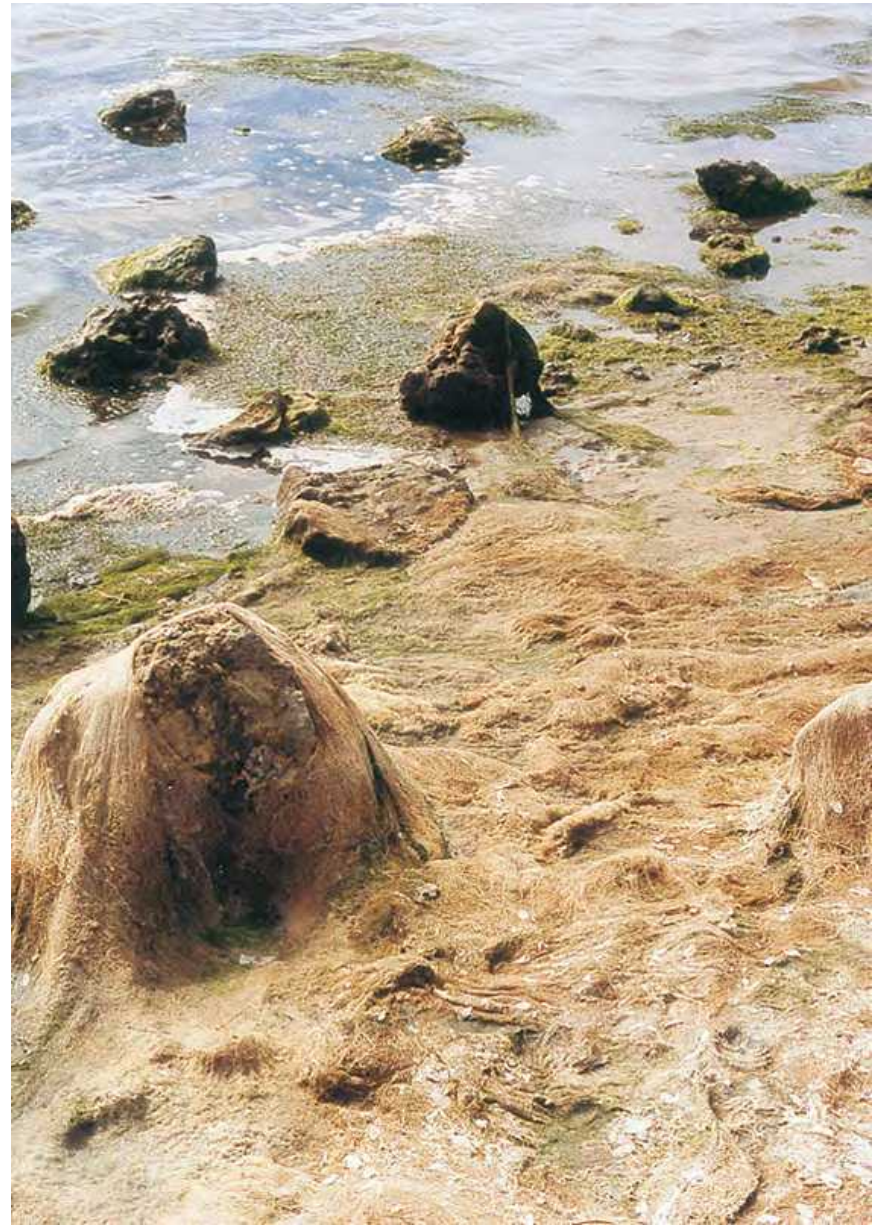


Giant kelp brown algae

Photo Mike Sugden

© Wet Paper Publications

If an aquatic plant such as algae (slime) is removed from water it forms a claggy mess, but in water it is supported and has a feathery appearance.



Algae on rocks
Photo Bob Moffatt

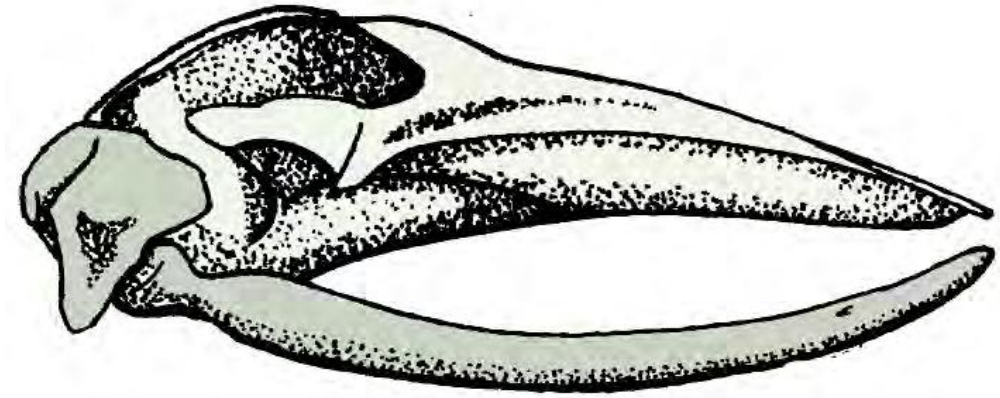
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Depth also impacts on bone structure.

The bones in the skeletons of aquatic animals are very different from those in terrestrial (land-living) animals.

The terrestrial animals need to have hollow bones to keep their weight to a minimum.

Aquatic animals mostly have solid bones as they have the water's upthrust reducing their weight.



Whale jaw

Illustration Steven Byers

© Wet Paper Publications

Another example of how the water supports the aquatic animals is seen when large marine animals such as whales and dolphins are beached.

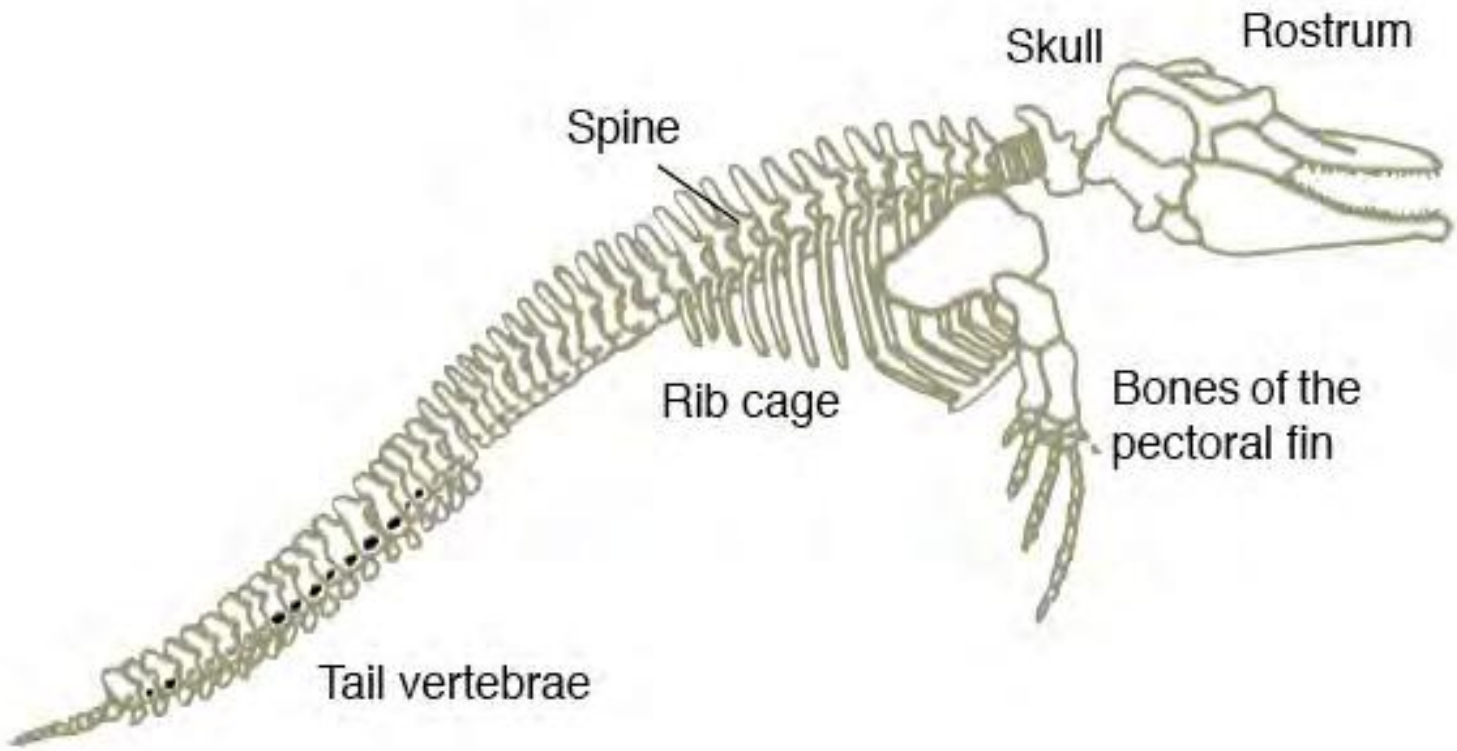
These animals often suffer broken rib bones, as the water no longer supports their weight. It is also harder for them to inflate their lungs



Whale on a beach

Photo Bob Moffatt

© Wet Paper Publications



Dolphin skeleton

Illustration Kerry Kitzelman

© Wet Paper Publications

Stratification

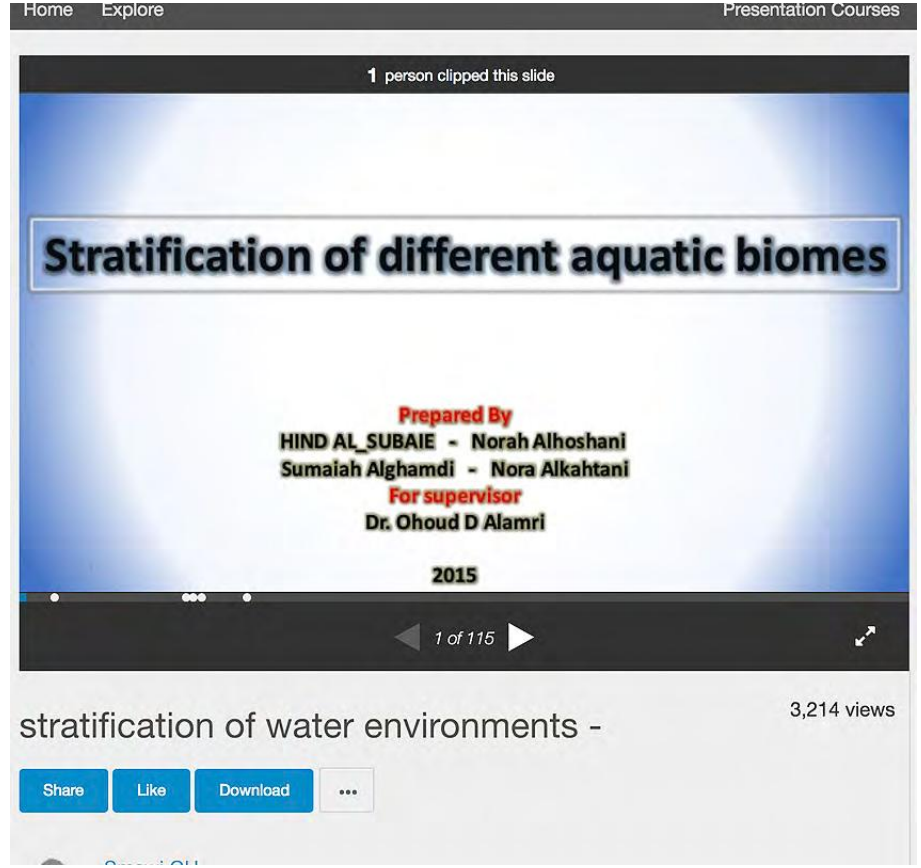
Stratification in the field of **ecology** refers to the vertical layering of a habitat.

However a more traditional view is that it relates to:

- Salinity
- Light
- Oxygen
- Temperature

An excellent set of slides can be found at

https://www.slideshare.net/sumaiahalghamdi/stratification-of-water-environments

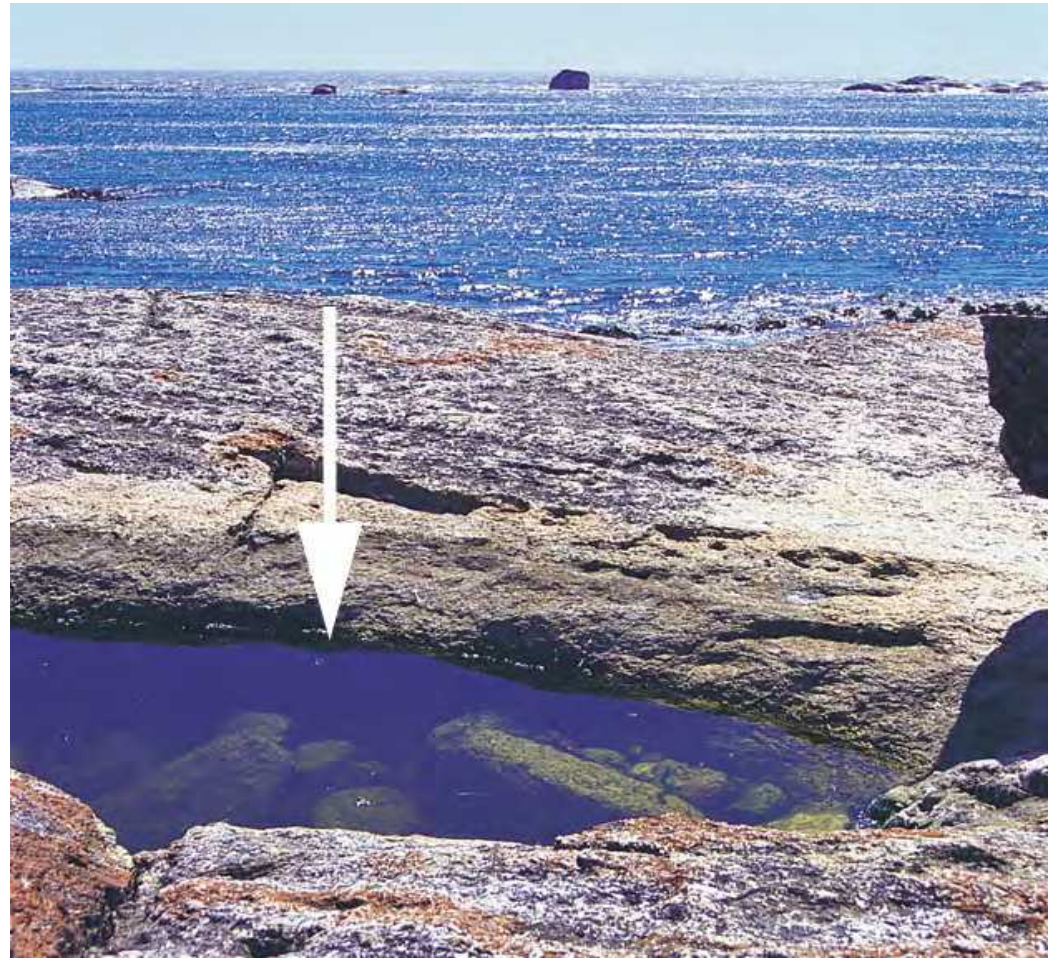


Stratification slide share pic
https://www.slideshare.net/sumaiahalghamdi/stratification-of-water-environments

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Temperature, salinity and availability of dissolved gases also plays a big role in the stratification of a habitat

- especially in rock pools

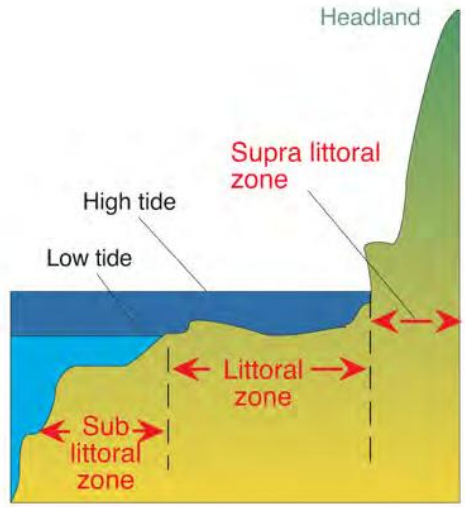


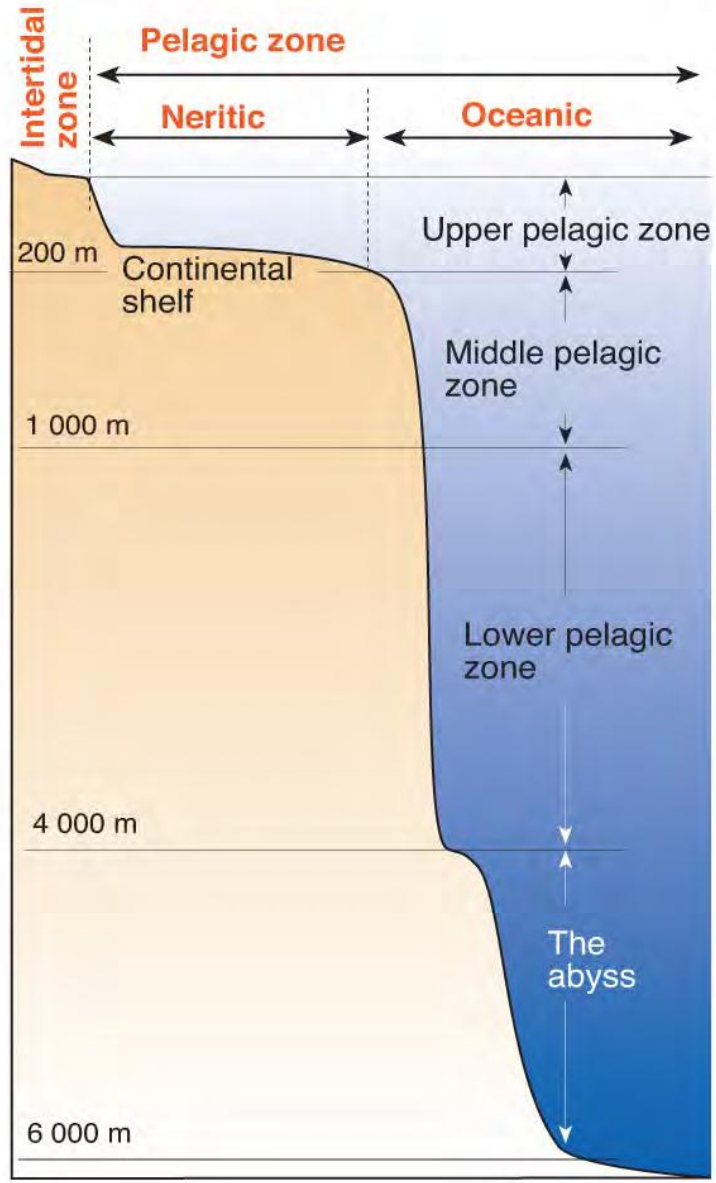
Rock pools with arrow showing place of high salinity and temperature

Photo Bob Moffatt

© Wet Paper Publications

These abiotic factors lead to the stratification of marine life into zones.





Zones in the sea

Illustrations Bob Moffatt

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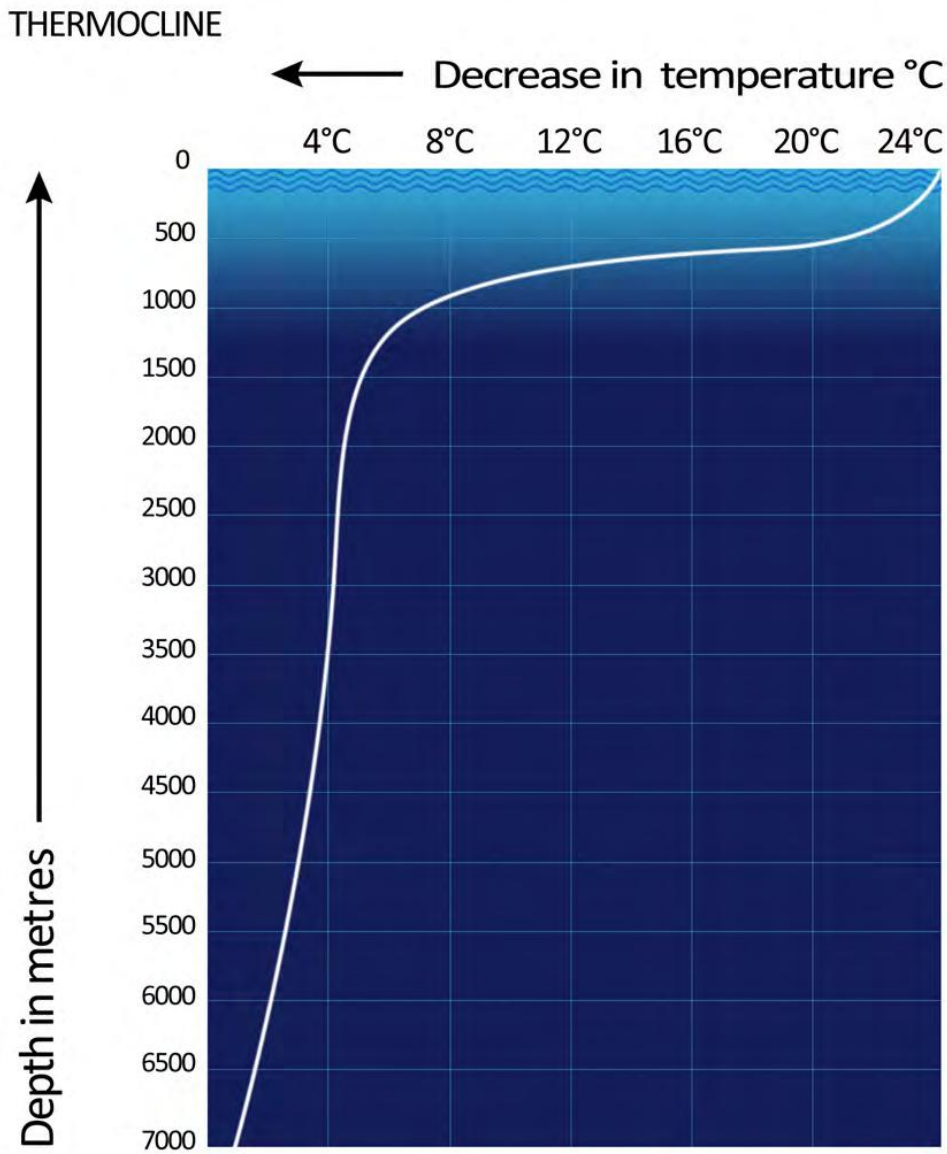
Temperature



Sun on coral from above
Photo Viewfinder Australia

© Wet Paper Publications

The temperature of the ocean decreases as you go towards the sea floor.



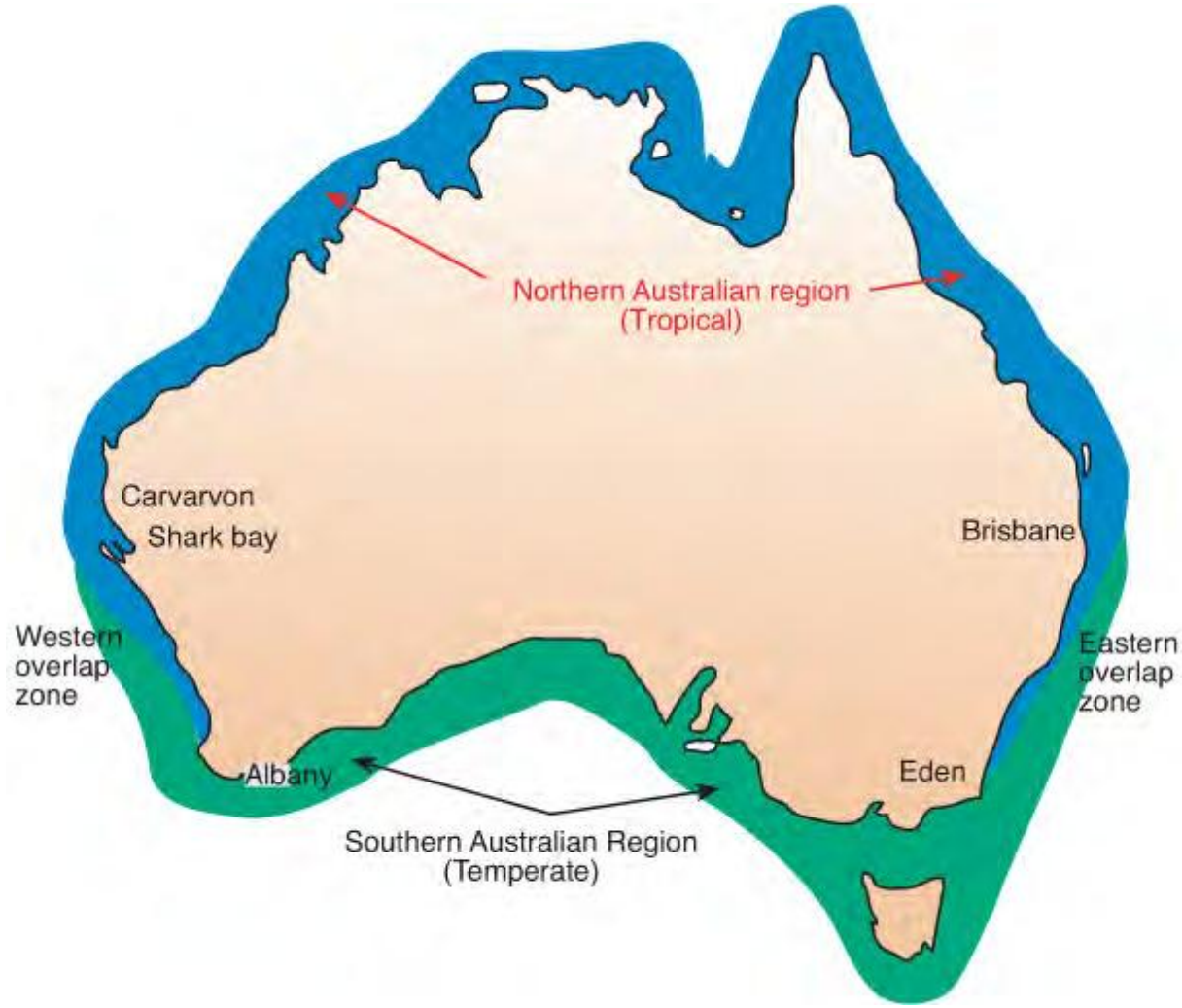
Thermocline

By Praveenron (Own work) [CC BY-SA 3.0 (https://creativecommons.org/licenses/by-sa/3.0)], via Wikimedia Commons

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Water temperature divides Australia into TWO marine biomes divided by temperature.

These are tropical and temperate regions.



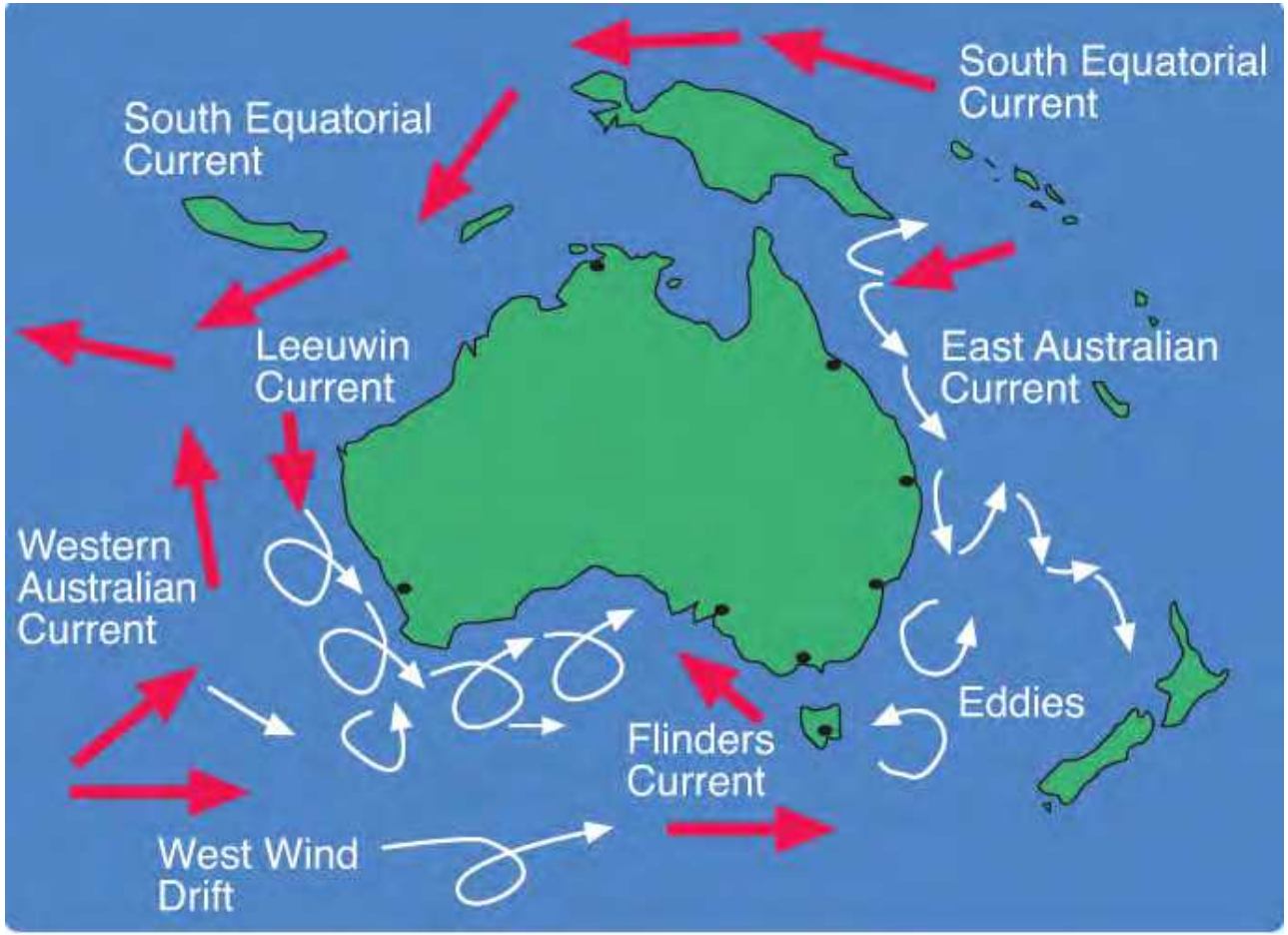
Australian bioregions

Illustration Bob Moffatt

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The boundary between the tropical and warm temperate provinces coincides approximately with 18-20^{o}C winter minimum surface temperature.

This is variable and dependent on the influence of the East Australian Current and the Leeuwin Current.



Australian currents

Illustration Bob Moffatt

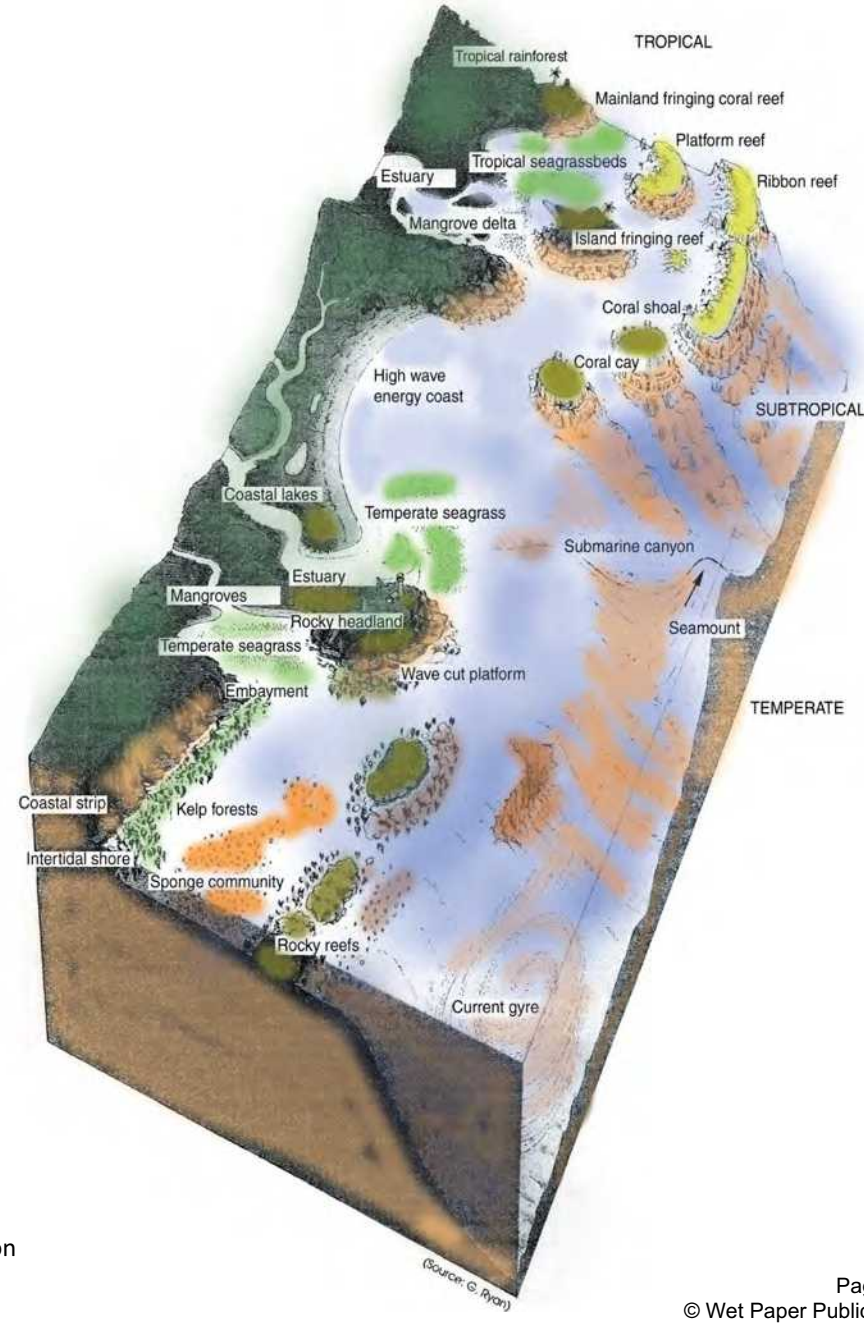
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Open shores in northern Australia are typified by extensive growths of coral reefs.

Sheltered shores support over 30 species of mangrove and have little salt marsh vegetation.

Northern coral reefs have a high diversity of fish and invertebrates.

However, only 10% to 15 % of northern Australian marine species are endemic (found only in that part of the world), Southern Australian Region.



Australian coastal zone ecosystems

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Southern Australian Region

Rocky shores in southern Australia are typified by extensive growths of massive brown seaweeds, called kelps.

Sheltered shores support extensive salt marshes and only one species of mangrove.

These shores have the world's highest diversity of seaweeds and some invertebrate groups. 80% to 90% of southern Australian marine species are endemic.



Fairy penguins
Photo Gould League

© Wet Paper Publications

The range of temperatures a marine organism has to endure depends also on the volume of water in which it is found - the smaller the volume of water the larger the range of temperatures.

A rock pool will only require a small amount of energy from the sun to cause a temperature fluctuation of 10°C.



Rock pools

Photo Bob Moffatt Illustration Sharryn Madder

© Wet Paper Publications

But a reef or ocean requires a large amount of energy to cause the same temperature fluctuation.



Reef aerial
Photo Viewfinder

© Wet Paper Publications

One impact of temperature is that fish can detect these changes in temperatures with receptors that are located all over their body.

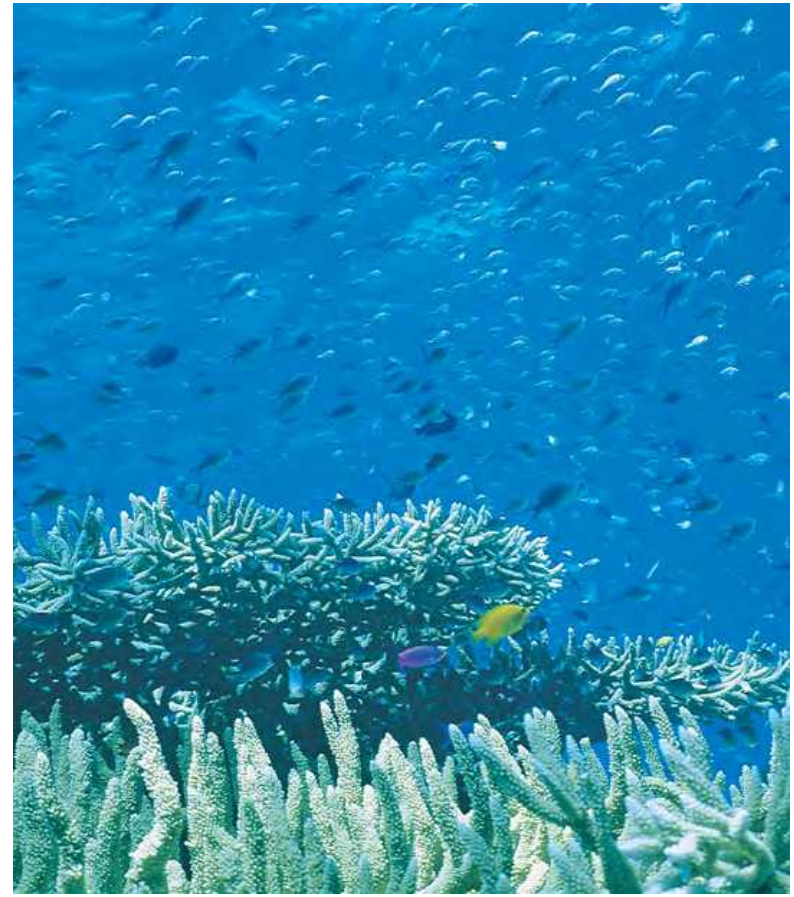
Fish are also cold-blooded or poikilothermic, which means that their body temperature varies in response to the temperature of their environment.

As a result their activity tends to become sluggish if the water temperature drops.

The change in temperature also causes the chemical reactions that take place in their body to speed up or slow down.

Many scientists believe that the stimulus for breeding of many species of fish is a change in water temperature.

Some fish migrate to areas that have different water temperatures to breed.



Fish on reef

Photo Below H20

© Wet Paper Publications

In tropical waters, water temperature also exerts a major control over the distribution of marine organisms.



Rocky shore and pool

Photo Bob Moffatt

© Wet Paper Publications

On a rocky shore, higher temperatures restrict animal size and so you see a decrease in shell size the hotter it gets.

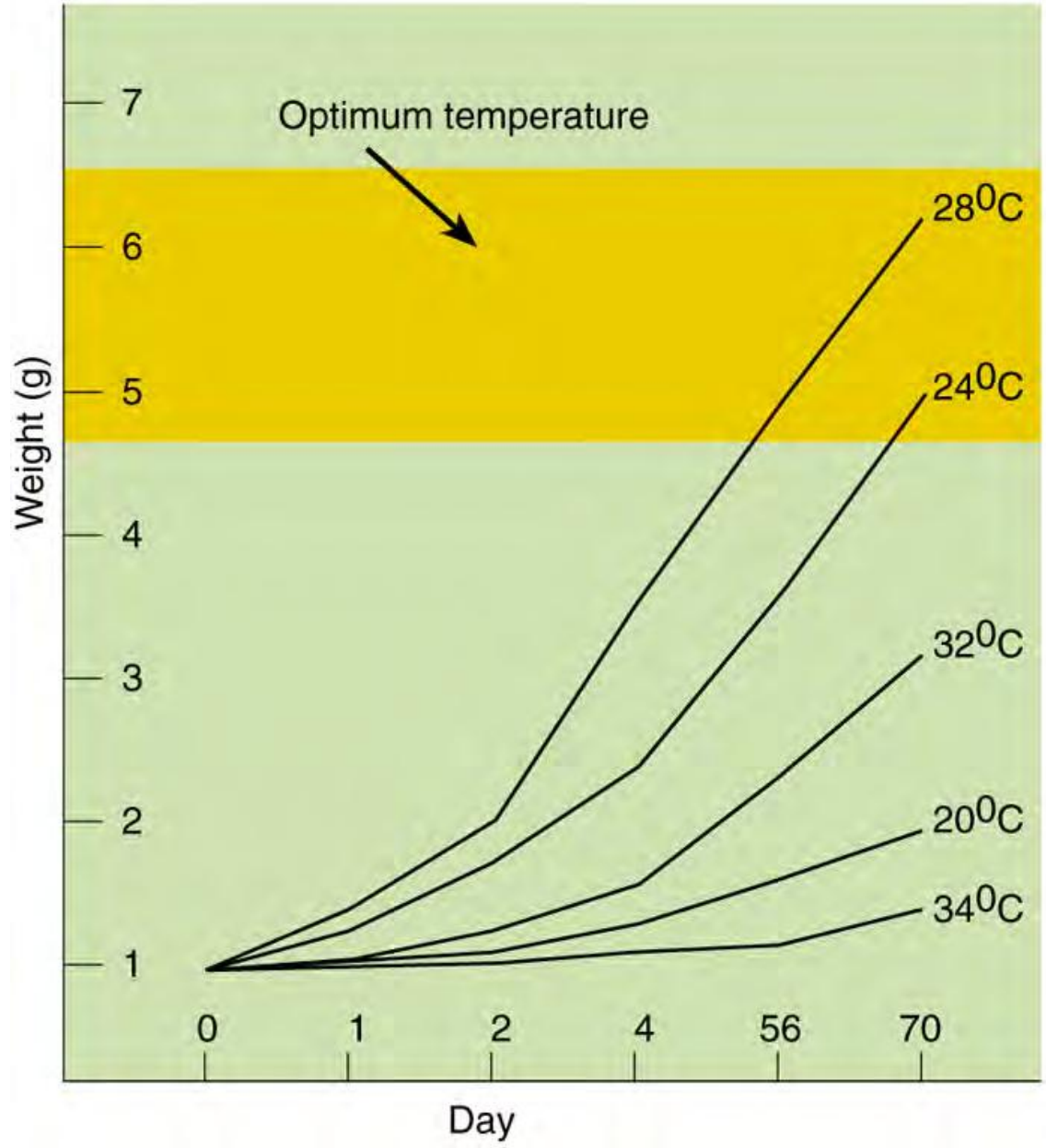


Nodular periwinkle on rocks

Photo Bob Moffatt

© Wet Paper Publications

Temperature can also affect growth rates in fish.



Growth rates and temperature

Illustration Dave Mason

© Wet Paper Publications

Temperature tolerances can differ widely between species.

Some species can withstand a wide range of temperatures and these are called eurythermic.

These eurytherms are mostly found in the shallower waters that have a greater temperature range.

An example is the green crab.

.



Green crab

By Lmbuga (Luis Miguel Bugallo Sánchez) (Own work) [GFDL (http://www.gnu.org/copyleft/fdl.html) or CC-BY-SA-3.0 (http://creativecommons.org/licenses/by-sa/3.0/)], via Wikimedia Commons

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Perhaps the greatest impact of temperature is on corals.

If the sea temperature rises coral bleaching occurs when coral polyps expel algae that live inside their tissues.



Bleached branching coral (Acropora sp.) at Heron Island, Great Barrier Reef.

By: J. Roff Acropora at English Wikipedia [CC BY-SA 3.0 (https://creativecommons.org/licenses/by-sa/3.0)], via Wikimedia Commons

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Waves and wind



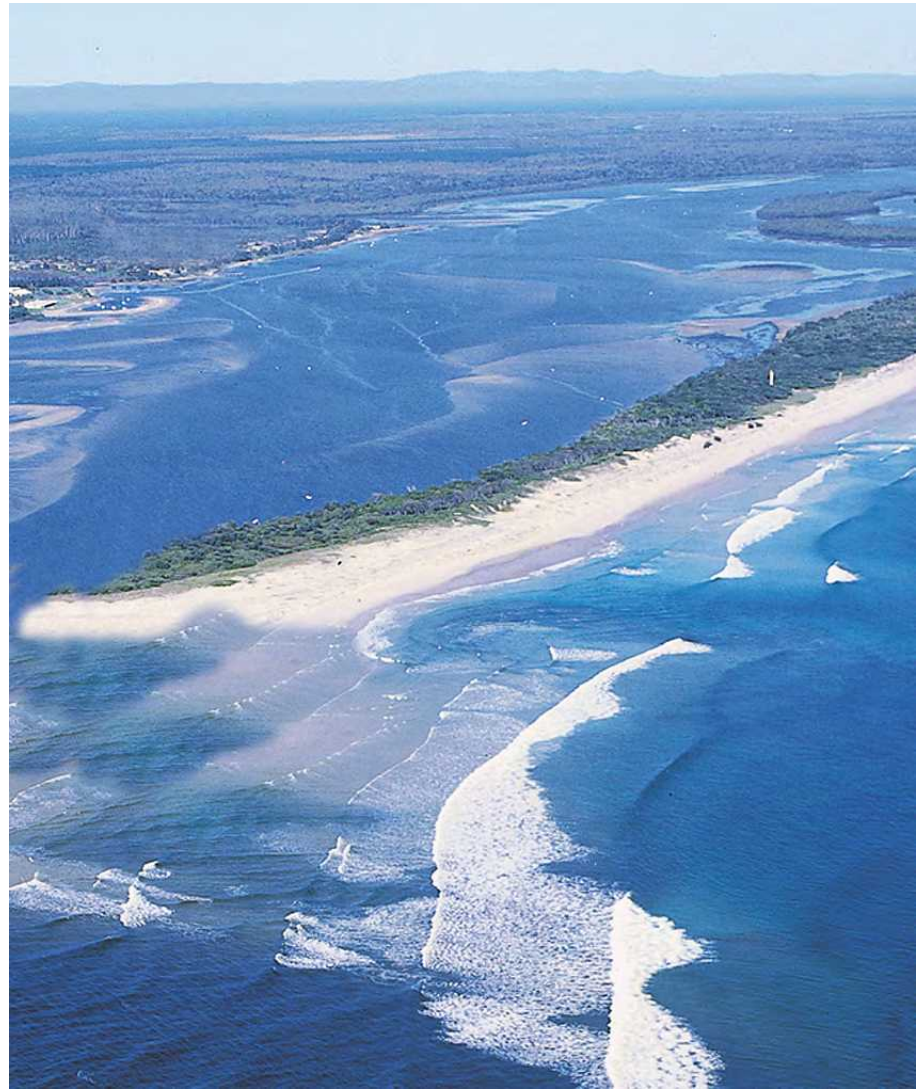
Waves Kiama
Photo Bob Moffatt

© Wet Paper Publications

If we fly up the Queensland coast you can see many areas where estuaries are protected from the sea by either reefs, offshore islands or coastal dune systems.

This creates areas of high and low energy.

Can you see them in the photograph?



Coastline and estuary

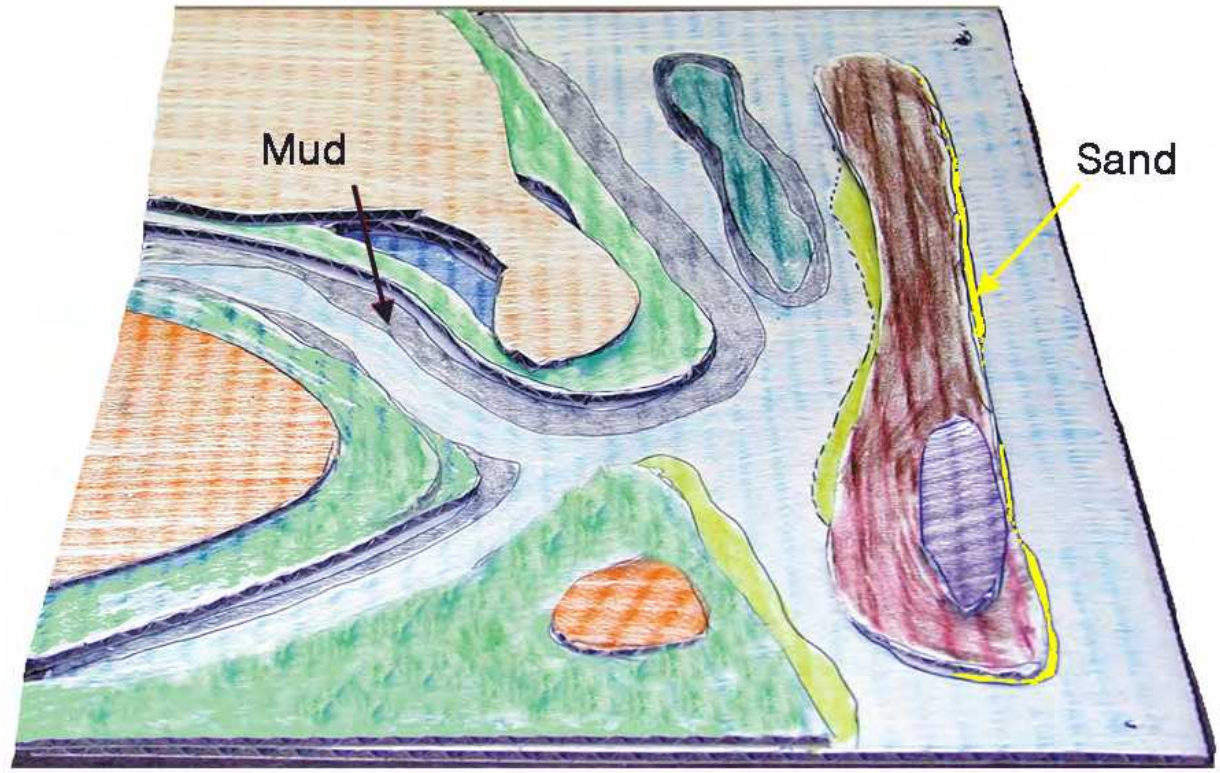
Photo Bob Moffatt

© Wet Paper Publications

The net affect is waves move sand along the coastline and create sand dunes, whereas in areas where there are no waves, mud forms making mangrove habitats.

So, if you built a model to distinguish between waves as an abiotic feature:

You would say the abiotic feature is waves, and where they have lots of energy, sand dunes form and where they have low energy, mudflats form.



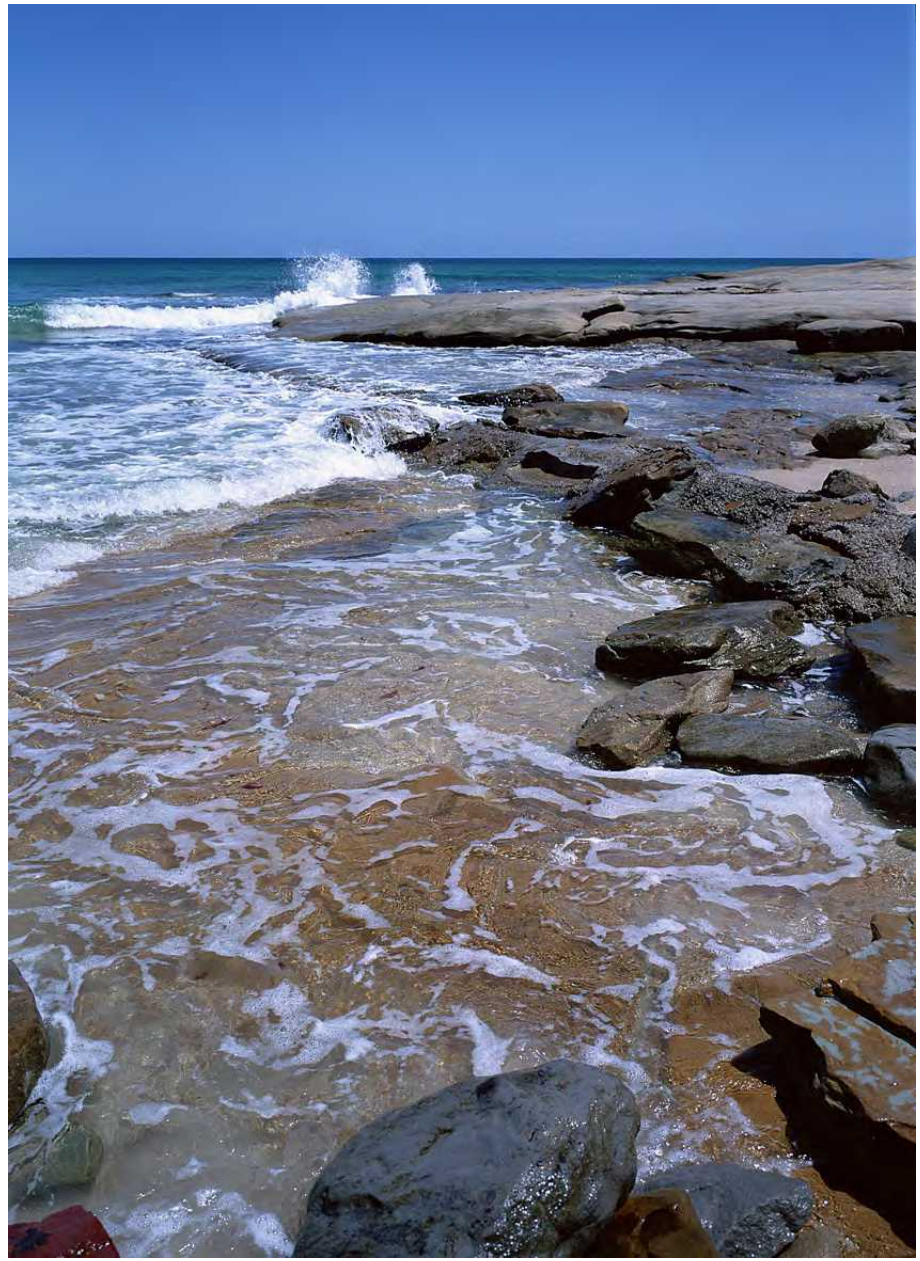
Sand mud wave energy zones

Photo and model Bob Moffatt

© Wet Paper Publications

Other affects of waves shaping habitats as an abiotic characteristic can be seen on the rocky shore.

Waves can shape the coastline as in a wave cut platform.



Wave cut platform at Noosa

Photo Bob Moffatt

© Wet Paper Publications

The impact of waves is that they determine where animals and plants are found on the exposed shore.



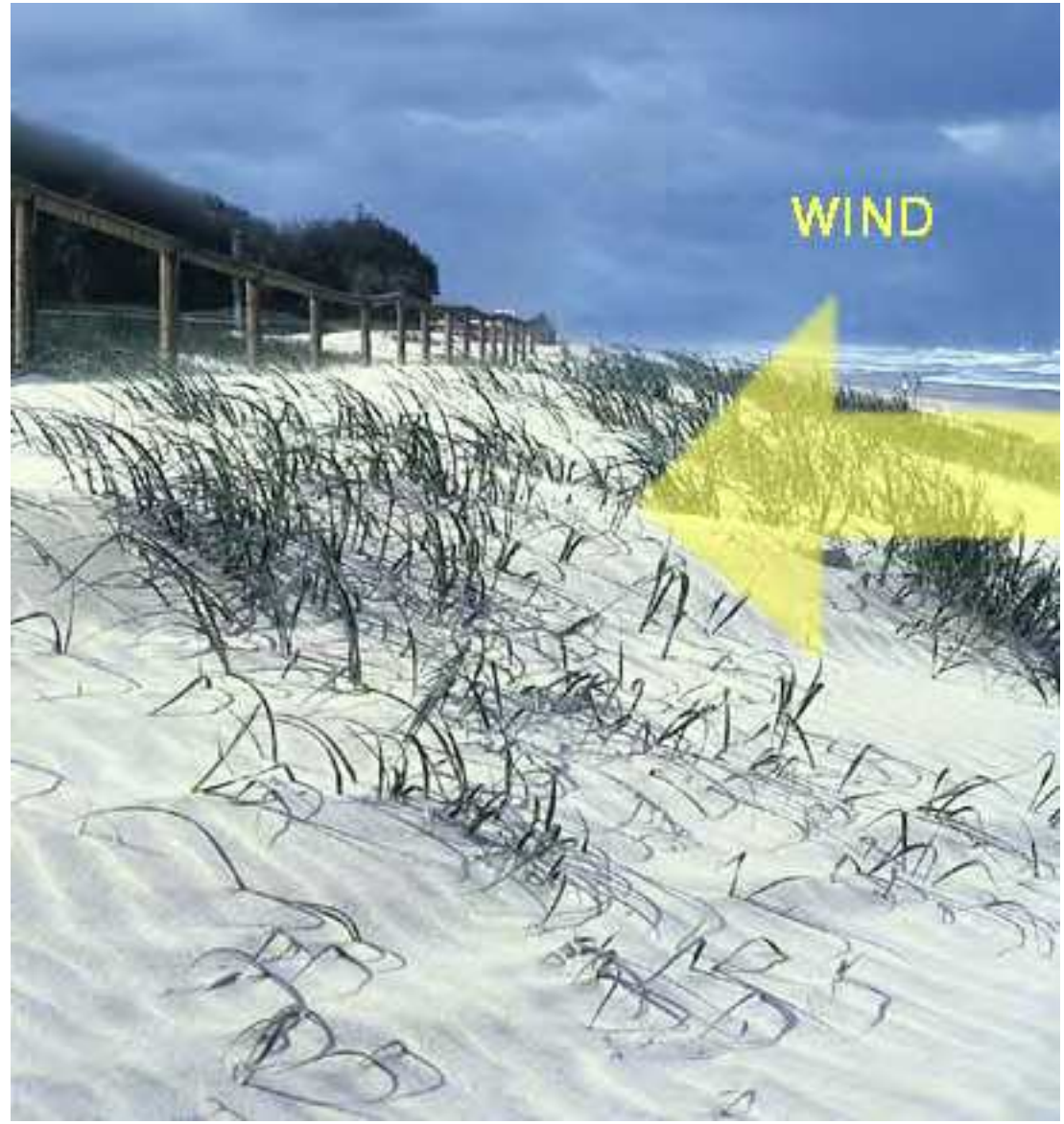
Waves breaking on an exposed shore
Photo Bob Moffatt

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Wind

Impacts include:

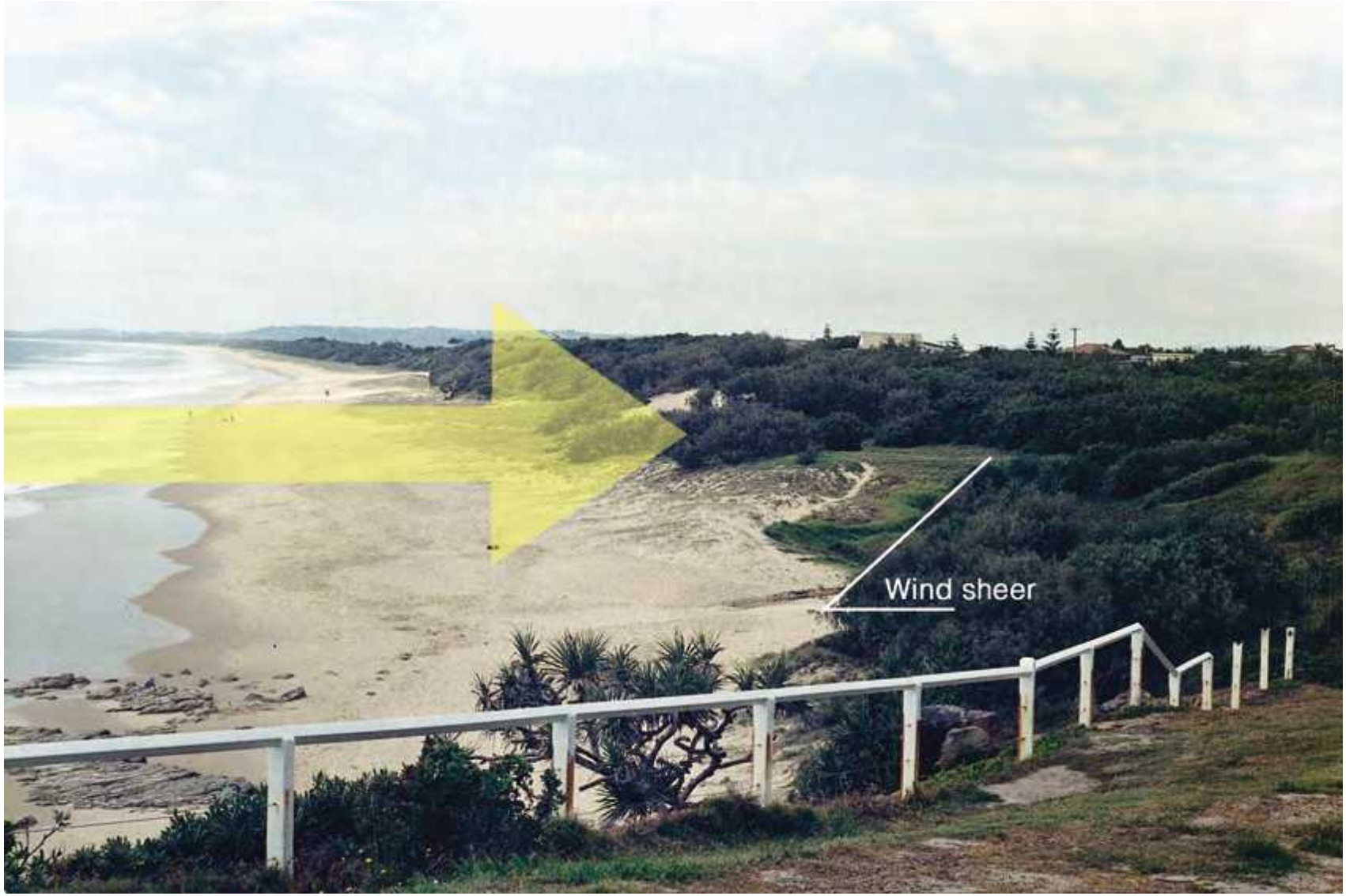
- Moving sand
- Shaping plant life
- Changing habitats



Wind moves sand up beach

Photo Bob Moffatt

© Wet Paper Publications



Wind sheer Queensland beach

Photo Bob Moffatt

© Wet Paper Publications

Coastal plants are shorter where prevailing winds are onshore.

Here the Banksia sp are less than 1 m tall.



Banksia trees onshore prevailing winds

Photo Bob Moffatt

© Wet Paper Publications

Where the prevailing winds are offshore, the Banksia sp here are 3m tall.



Banksia prevailing winds off shore

Photo Bob Moffatt

© Wet Paper Publications

The impact of wind can be see if you go to North West Island on the Great Barrier Reef and walk around the island.

On the leeward side the Casurinas trees are at least 4m tall whereas on the windward side they are sheared back to half the size.



North West Island windward and leeward

Photos Bob Moffatt

© Wet Paper Publications

Whereas inside the island, where there is little wind, the Pisonia trees can grow to at least five metres.

Other effects include:

- Trade currents
- Affect distribution of animals
- Peruvian anchovies
- Herring migration



North West Island Pisonia forest
Photo Bob Moffatt

© Wet Paper Publications

Currents

- carry reproductive materials
- bring nutrients
- carry freshwater



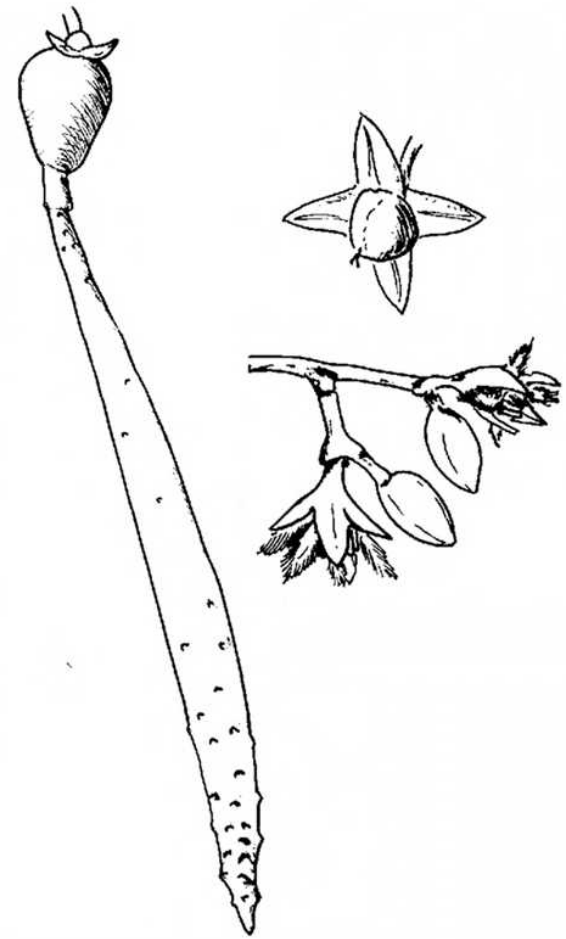
Students and current drogue

Photo Bob Moffatt

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These mangrove seeds are distributed along our coastline by currents.





Mangrove seed and fruit illustration

Photo and illustration Bob Moffatt

© Wet Paper Publications

Currents carry and distribute reproductive materials.



Mangrove seed and fruit

Photo and illustration Bob Moffatt

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Currents can cause erosion in estuaries.



Erosion on an estuarine river bank
Photo Bob Moffatt

© Wet Paper Publications

Currents can move large volumes of biomass.



Biomass moved by currents on a beach
Photo Bob Moffatt

Consider also
Gyres
Gulf stream
Eddies
Upwellings

Great ocean conveyor belt

© Wet Paper Publications

Tides



Big tide at Broome

Photo Broome Historical Society

© Wet Paper Publications

Tides

- expose organisms to predators
- expose habitats to sun and increased temperatures
- flood habitats with seawater



High tide and low tide comparison

Photos Bob Moffatt

© Wet Paper Publications

In mangrove habitats, tides play a big role in stratification from the waters edge.

They expose large areas of habitat to predators and force many animals into the mud.



Mangroves waters edge
Photo Bob Moffatt

© Wet Paper Publications

Further inland, low tide exposes coastal grasses which must be salt tolerant when the tide comes in.



Mangroves inland saltmarsh
Photo Dave Claridge

© Wet Paper Publications

Low tides however provide feeding ground for a wide variety of wading birds.



Spoonbills feed at low tide
Photo Bob Moffatt



© Wet Paper Publications



Ibis feeding at low tide

Photo Bob Moffatt

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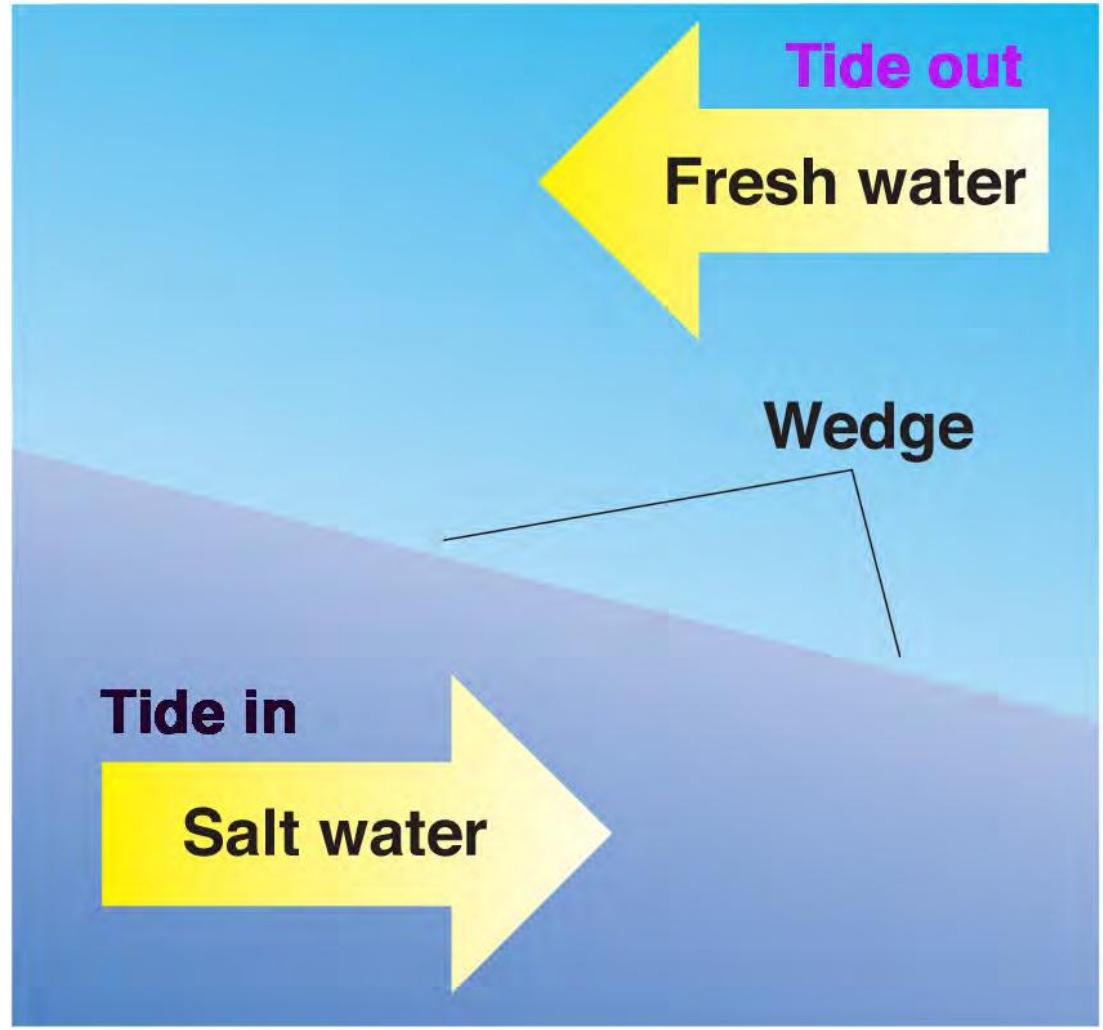
Fiddler crab low tide habitat

Photo Bob Moffatt

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Salinity levels within an estuary are dependent on the tides.

During low tide, salt water influx levels are reduced.



Salt water wedge

Illustration Bob Moffatt

© Wet Paper Publications

As tides come and go, fish need to account for this change in salt concentration.

In order for water to enter cells, it has to pass through a cell membrane and the mechanism regulating this is called osmosis.



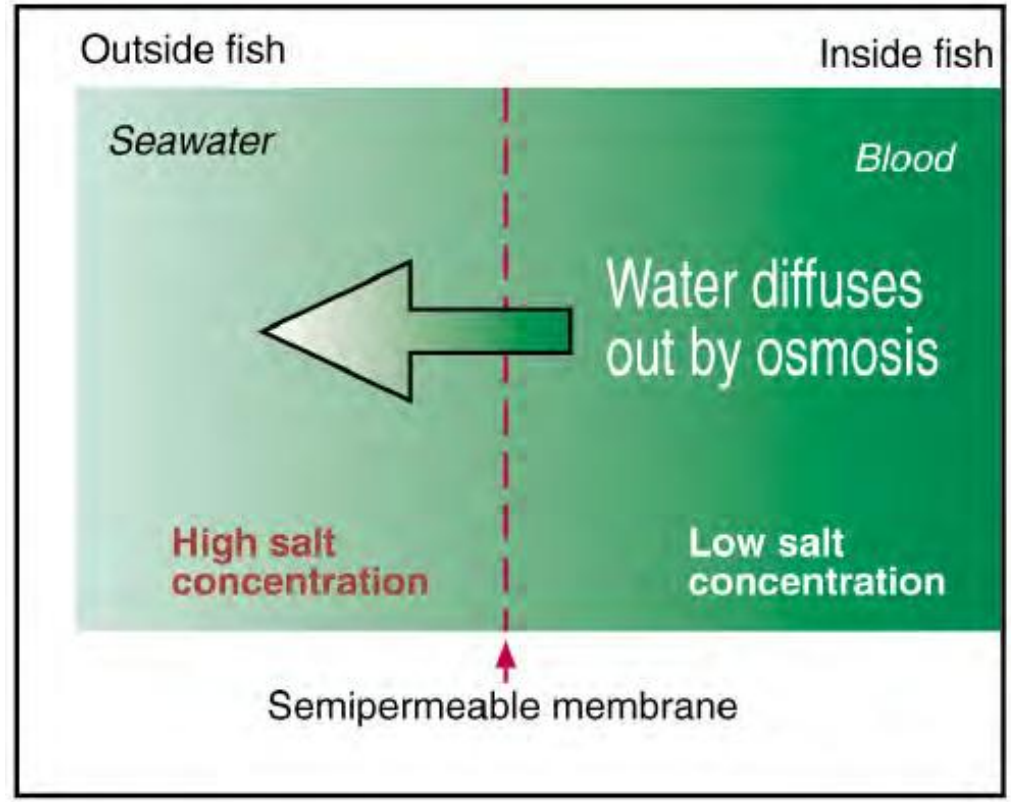
Incoming tide to an estuary
Bob Moffatt

© Wet Paper Publications

The membrane through which the water moves is semi-permeable and allows some substances through while inhibiting others, eg water can pass through easily but not salt, as salt is a larger molecule.

The diffusion of water will depend on there being a difference in concentrations on either side of the semi-permeable membrane.

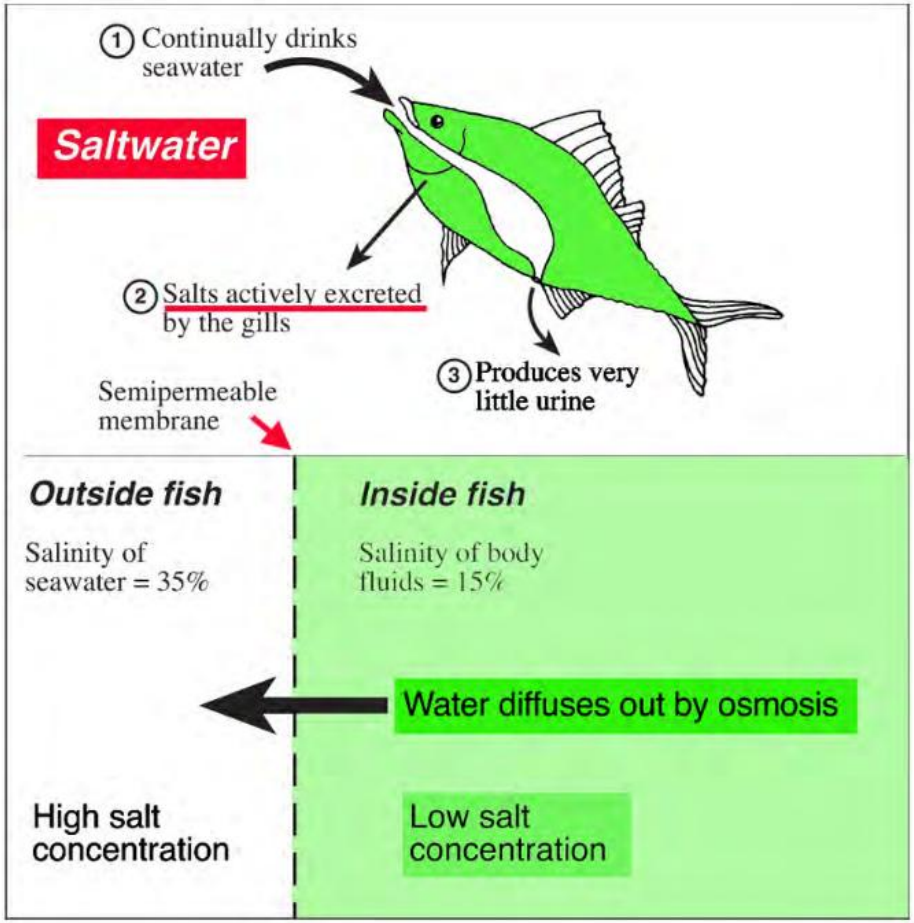
Applying the laws of diffusion, water will diffuse from an area of low salt concentration to an area of high salt concentration presumably in an effort to dilute the salt.

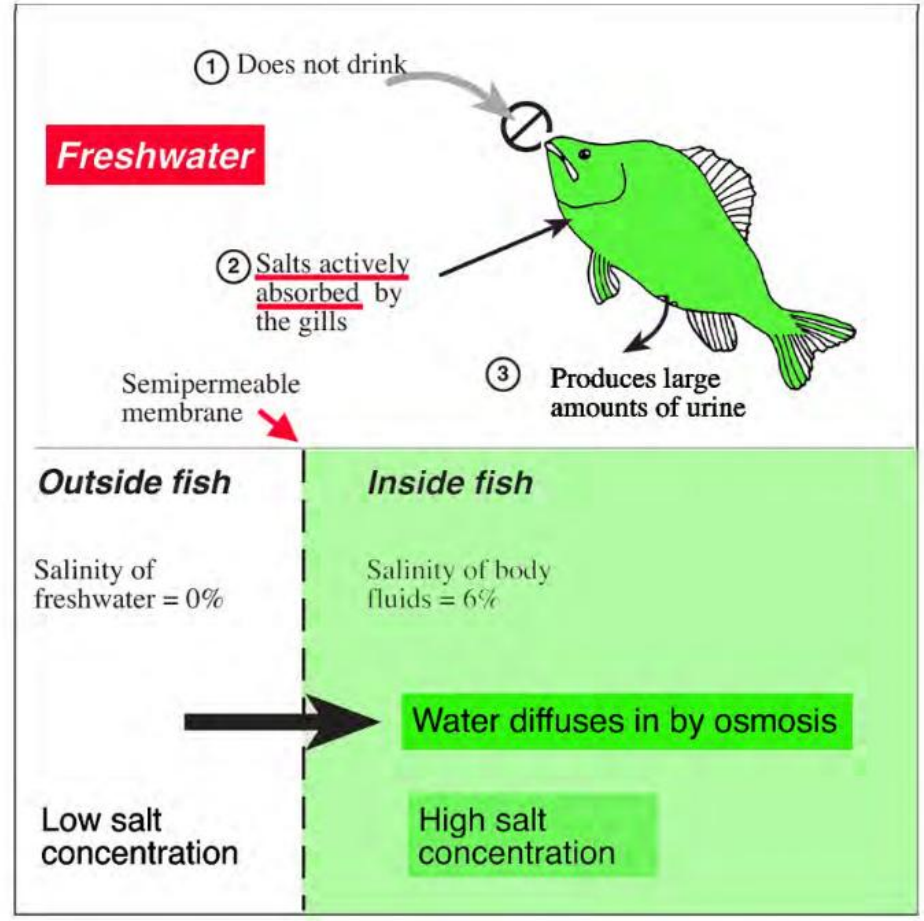


Osmosis

Illustration Bob Moffatt

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Osmosis saltwater to freshwater

Figure Bob Moffatt

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Many estuarine plant species are halophytes.

These are plants that can tolerate salty water on their roots or sea spray. In these plants, filters in the roots exclude the salt from the water that the plant absorbs.



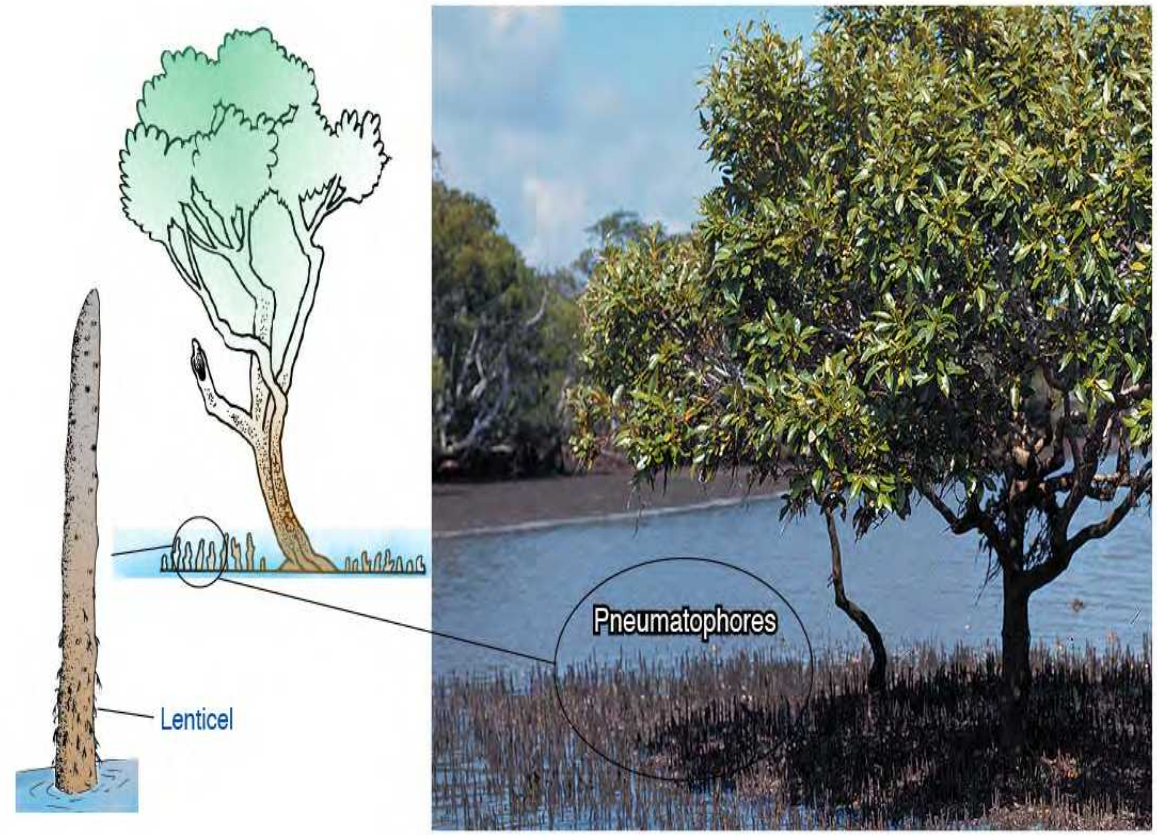
Seagrass at low tide
Photo Bob Moffatt

© Wet Paper Publications

The specialized aerial roots of mangroves enable plants to breathe air in habitats that have waterlogged mud.

The roots may grow down from the stem, or up from typical roots. Some botanists classify these as aerating roots rather than aerial roots, if they come up from soil.

The surface of these roots are covered with lenticels (small pores) which take up air into spongy tissue which in turn uses osmotic pathways to spread oxygen throughout the plant as needed.



Pneumatophores

Photo Bob Moffatt Illustration Rose Bedford

© Wet Paper Publications

Animals, such as mussels and clams, have developed behavioural adaptations that expend a lot of energy to function in this rapidly-changing environment.

When these animals are exposed to low salinity, they stop feeding, close their shells, and switch from aerobic respiration (in which they use gills) to anaerobic respiration (a process that does not require oxygen).

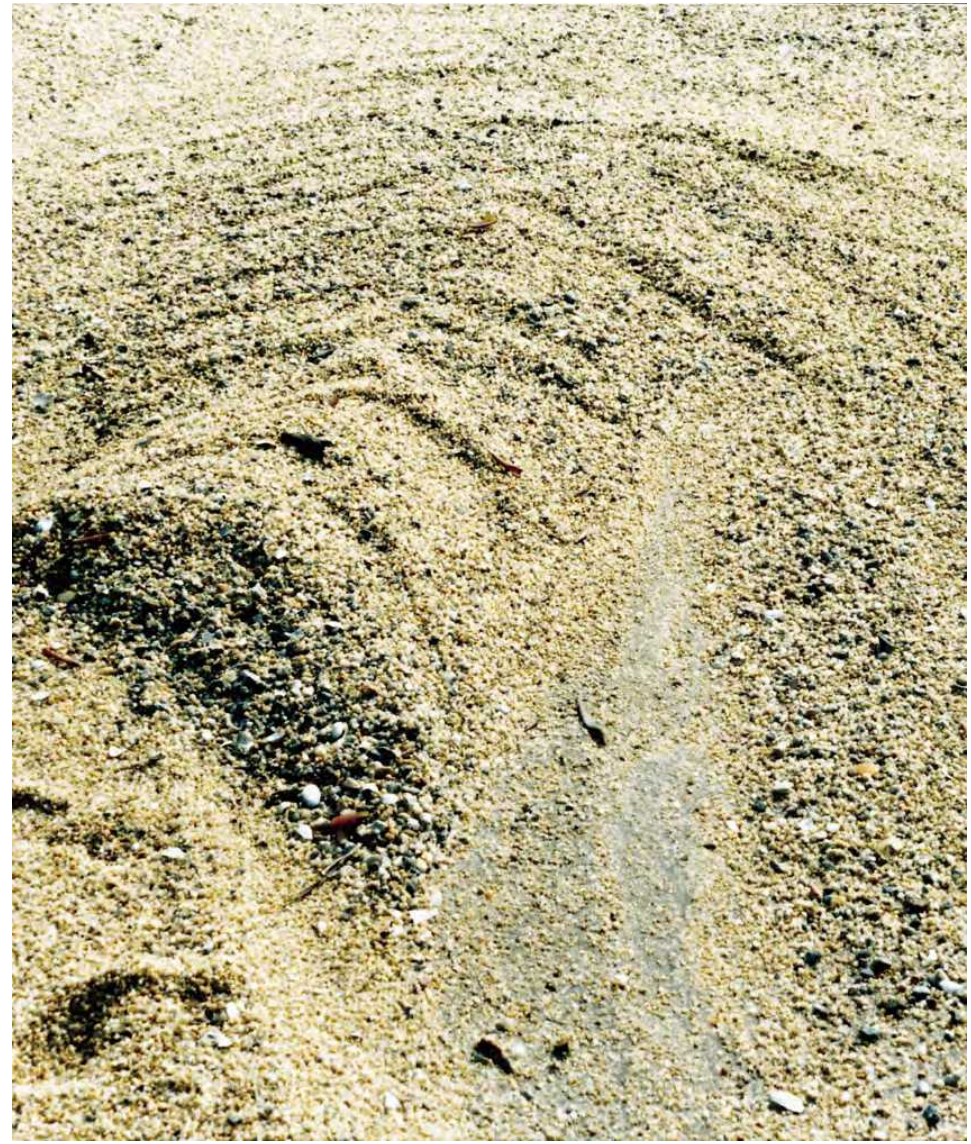
When high tide returns to the estuary, the salinity and oxygen content of the water increases, causing these animals to open their shells, begin feeding, and to return to aerobic respiration.



Mussels in an estuary
Photo Ruth Fairley

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Sediment type

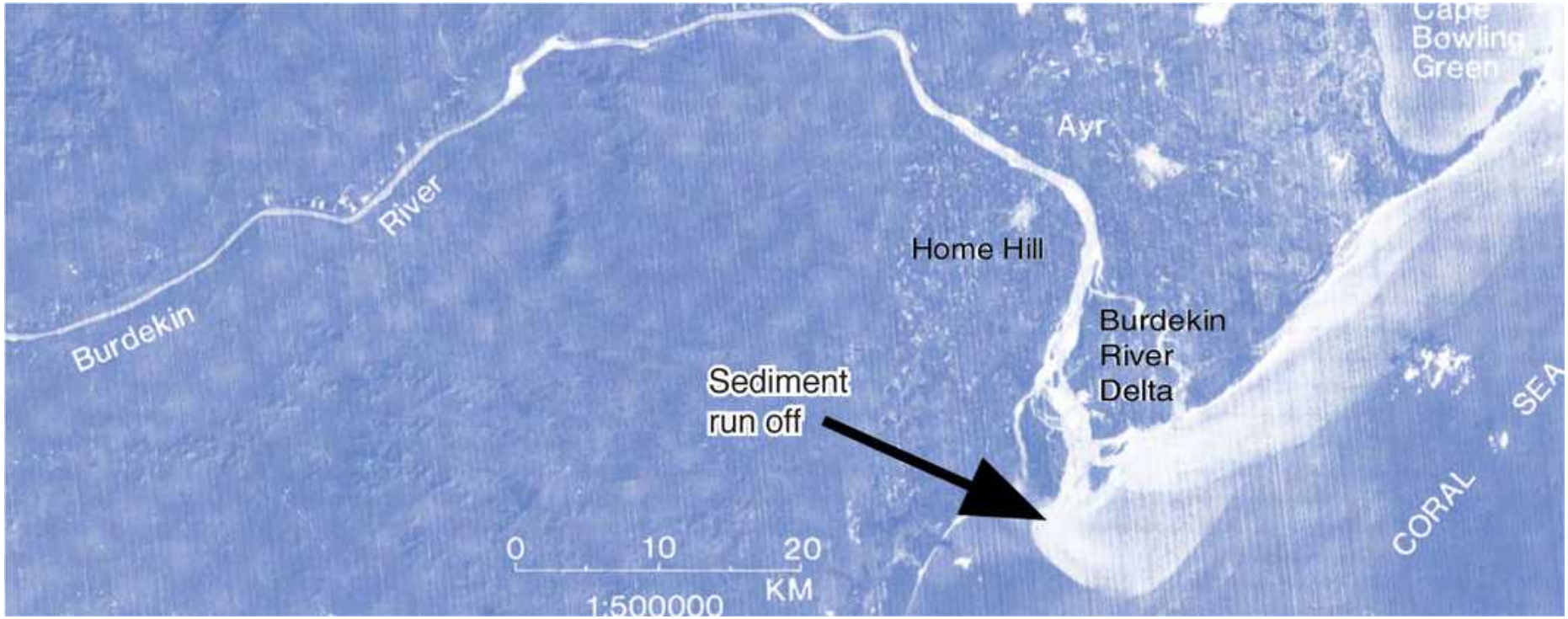


Sand sediments

Photo Bob Moffatt

© Wet Paper Publications

Water from the land carries huge amounts of sediments which can greatly affect local marine habitats. The figure below shows a sediment plume flowing out of a coastal river.



Sediment plume to coral sea

Photo Beach protection authority

© Wet Paper Publications

This has great consequences for filter feeding animals. As the silt moves over the continental shelf, it will gradually flow down the continental slope till it reaches the deep sea.

Animals and plants that live here will need to cope with these layers of deep sea ooze.

Sediments from coastal towns and cities can also have devastating effects on habitats.



Stormwater and sediment
Photo Bob Moffatt

© Wet Paper Publications

The figure shows two types of sediment - course sand and fine mud.

Mangroves can grow in mud, but coastal spinifex cannot, leading to two different types of habitat.

Sand dune and mangrove.

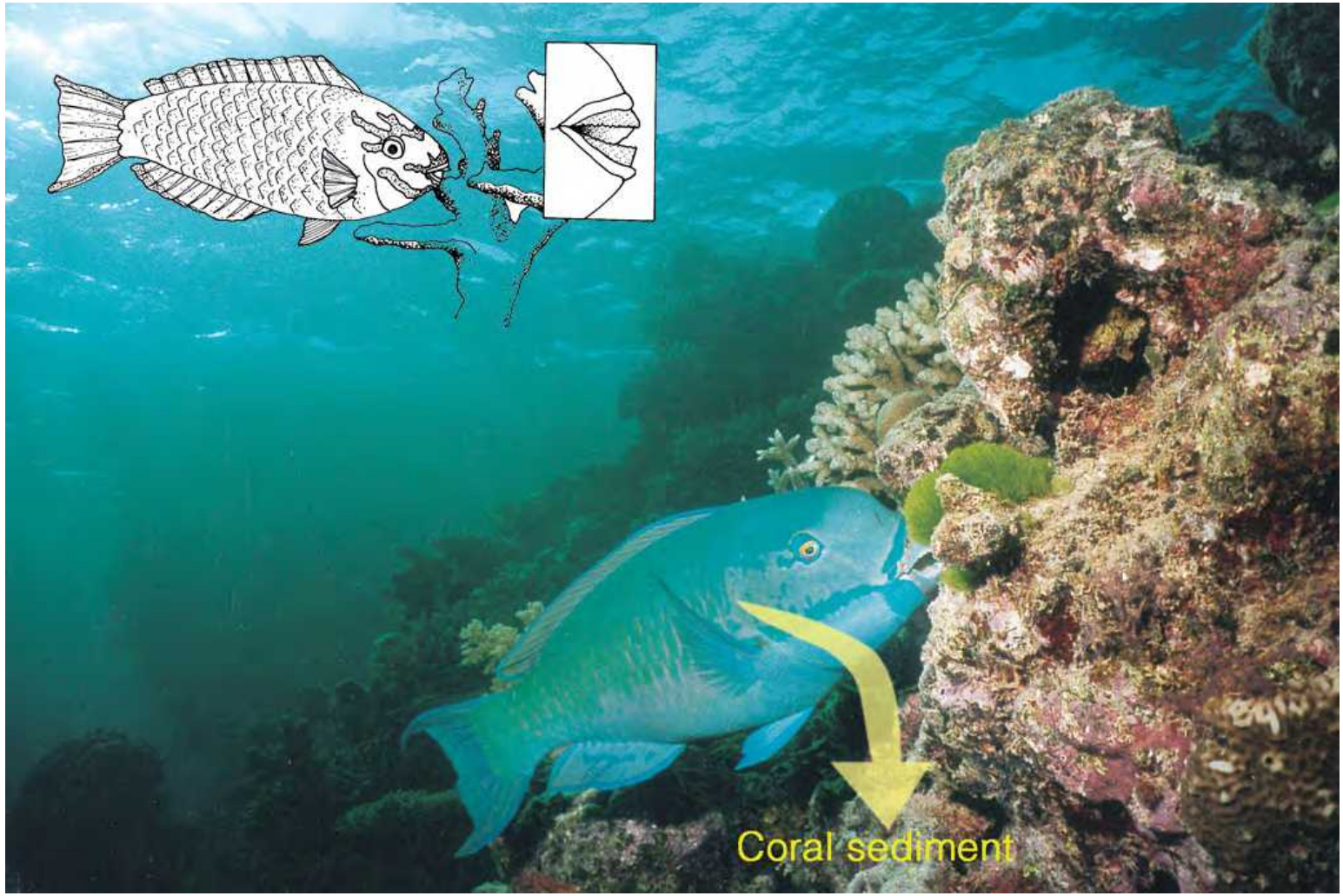


Two sediment types

Photos Bob Moffatt Queensland Fisheries

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Sediments are also made in reefs by fish that graze on corals.



Parrot fish and coral sediment

Photo Bob Moffatt Illustration Steven Byers

Further research or discussion

Carbonate and non carbonate sands – their origin and significance in ecology.

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Nutrient availability



Seagulls and seaweed
Photo Bob Moffatt

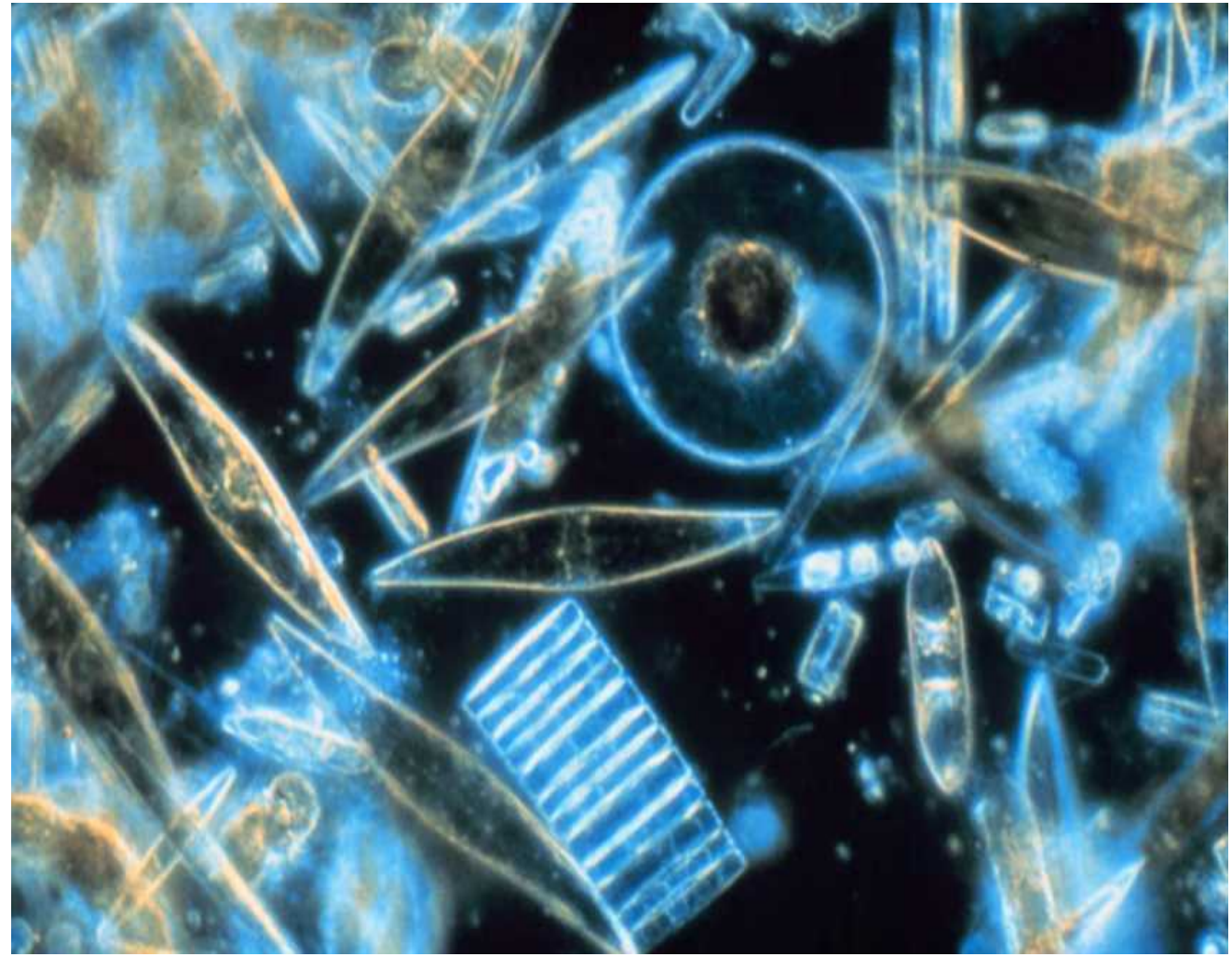
Seaweed provides a huge source of nutrients for life on an open beach.

© Wet Paper Publications

The most important nutrients for phytoplankton growth in the ocean are nitrate and phosphate.

Some types of phytoplankton, called diatoms, also require the nutrient silicate, which they use to build their cell walls.

Plants in the surface waters of the ocean take up these dissolved nutrients during photosynthesis.



Diatoms through the microscope

By Prof. Gordon T. Taylor, Stony Brook University (corp2365, NOAA Corps Collection) [Public domain], via Wikimedia Commons

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Phosphorus is an important element for spinifex which has an active root system to seek out this element.

When quartz and feldspar are formed, they contain a fine coating of phosphorus which sticks to the sand grain as it moves along the coast.

When the sand grains are washed up on the beach, they dry and are blown towards the spinifex.



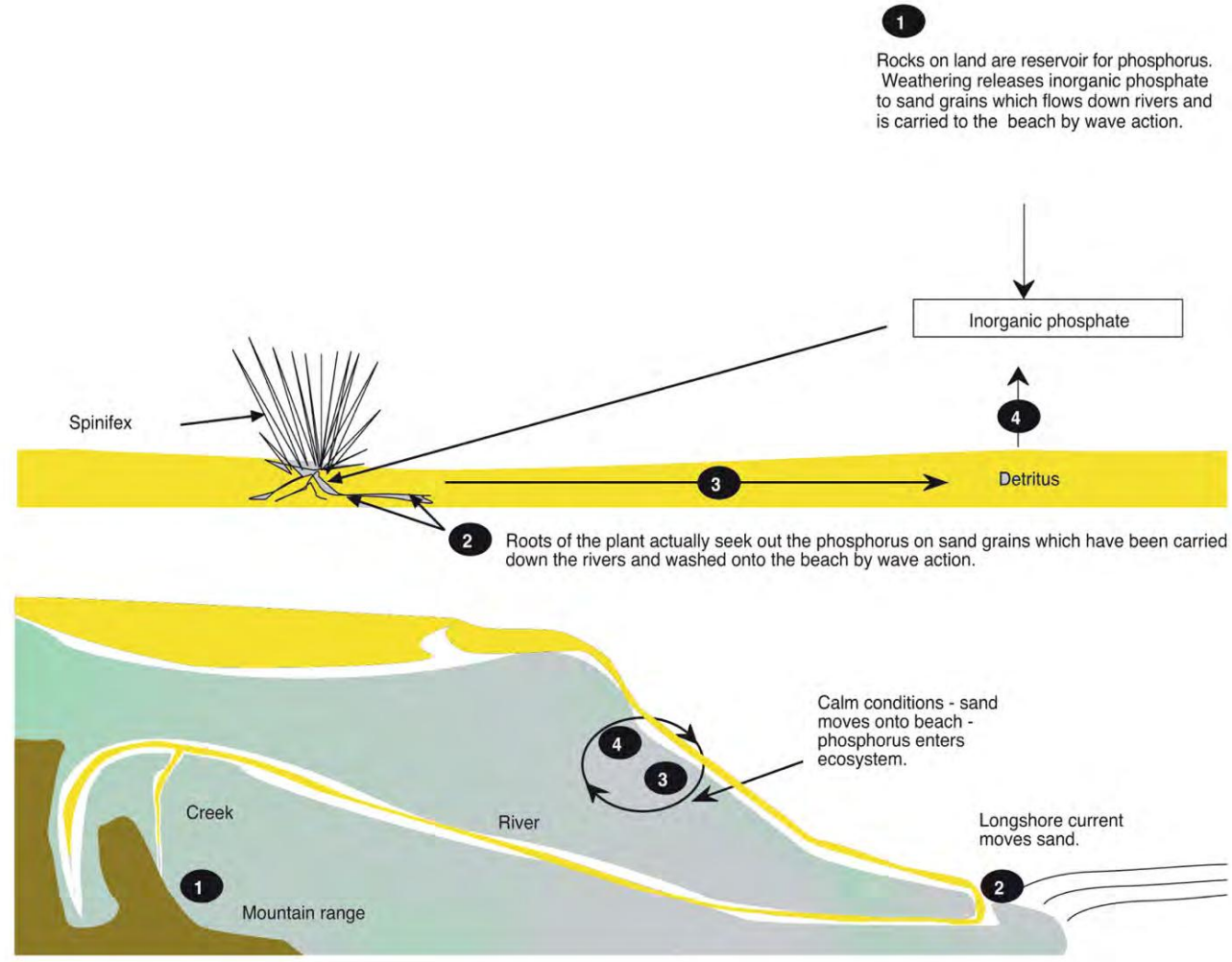
Coastal spinnifex
Photo Bob Moffatt

© Wet Paper Publications

The broad leaf of the plant catches the grain by reducing the wind velocity and the grains falls to the base of the plant.

Fine root hairs that grow from the main plant then absorb the phosphorus coating from the sand grain.

Has been done already – use as revision



Spinifex and the phosphorus cycle

Illustration Bob Moffatt

© Wet Paper Publications

Casuarina trees are able to convert the nitrogen in the atmosphere to a solid form inside the tree.

This is done by micro-organisms, called nitrogen fixing bacteria, that live in root nodules at the base of the tree.



Casuarina

Photo Beach protection authority

Has been done already – use as revision

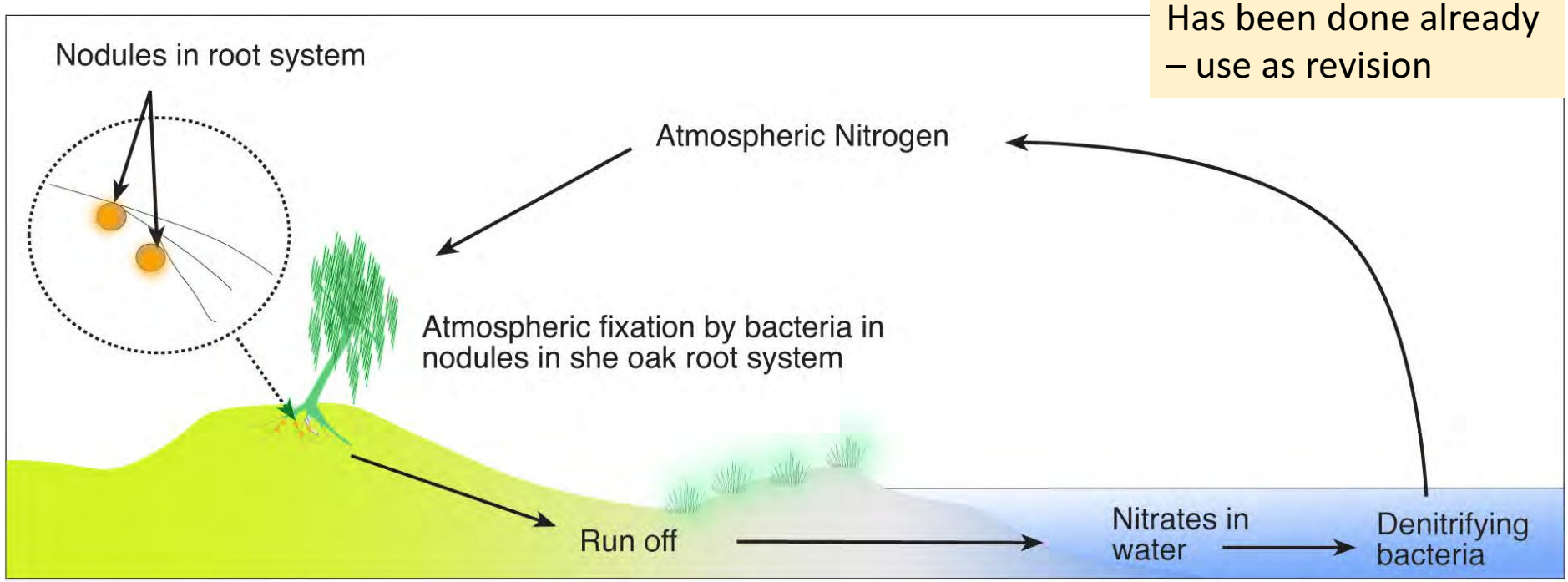
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The bacteria absorb the atmospheric nitrogen and convert it to a bound or “fixed” chemical form that can be released as a fertiliser to help the tree to grow.

This may be one reason why the tree grows so quickly.

This process is called nitrogen fixation and is part of the nitrogen cycle that is so important to the survival of the sand dunes.

Has been done already – use as revision



Nitrogen cycle in Casurina

Illustration Bob Moffatt

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Pisonia trees live on coral cays.

These coral cays are made from sand with few nutrients, so large trees called Pisonia's attract birds bringing nutrients to the cay.

The trees are weak and break, adding nutrients, but then grow quickly to add to the cay’s carbon load.



Pisonia tree and students

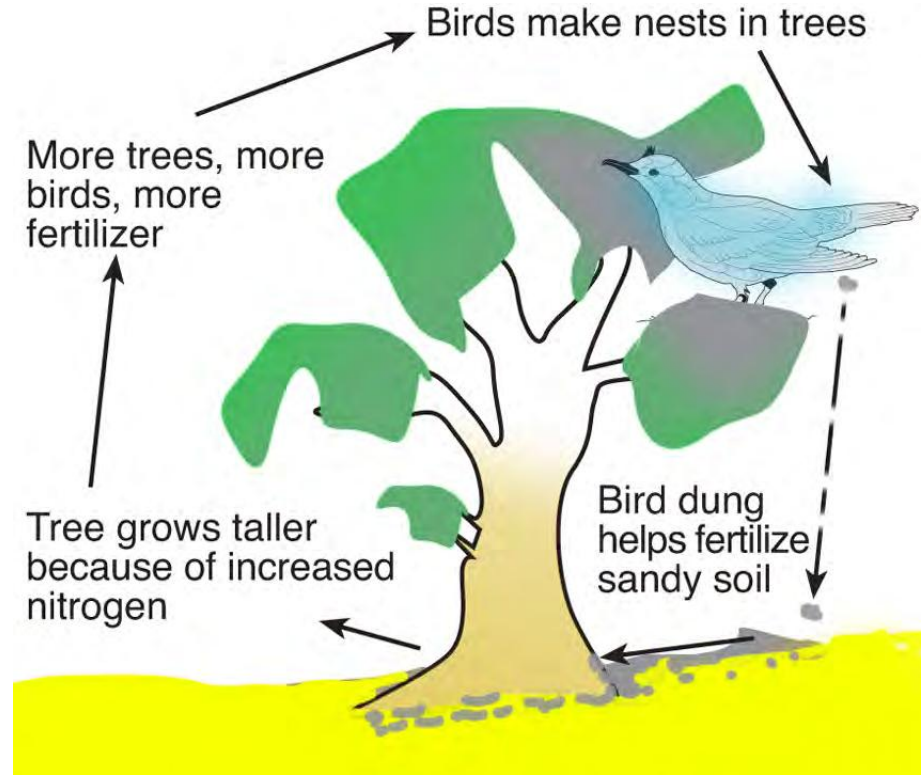
Photo Bob Moffatt

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A large amount of bird dung fertilises the soil making available nutrients for the plant.

A cruel fate though as the unique seed of the tree traps birds in summer, causing death but ensuring the tree more nutrients.

Tree catches and kill the birds so it can get fertilizer.



Pisonia tree bird nitrogen

Illustration Bob Moffatt

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Salinity

Salinity is an important nutrient for plant growth.

Estuarine grasses such as salt water couch and samphires require this salt for growth.

These grasses are important for dune development and stabilising wind eroded areas.



MOVE?

Salt water couch – note the colour change in the couch

Photos Bob Moffatt

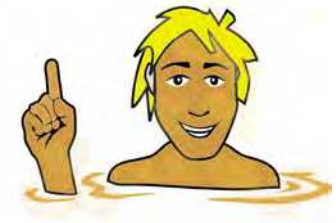
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So can you now?

Note points of difference between the following abiotic features in a variety of marine environments

Light availability
Depth
Stratification
Temperature
Waves
Currents (water and wind)
Tides
Sediment type
Nutrient availability

Distinguish



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Question

Complete the table to show how each of the following abiotic features impact the survival of animals and plants in the marine environment.

Abiotic feature	How feature impacts on the survival of animals and plants in the marine environment
Light availability	
Depth	
Viscosity	
Stratification	
Temperature	
Waves	
Currents (water and wind)	
Tides	
Sediment type	
Nutrient availability	

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Video references

You may want to see what one high school class from Pinelands High School from South Africa thought of the abiotic factors on their rocky shore.

https://www.youtube.com/watch?v=yLVkffjtG-g

Effects of Abiotic Factors on the Rocky shore (DO's class)

4.52 minutes



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T053 Limiting factors and tolerance limits



Bob Moffatt

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Syllabus statement

At the end of this topic you should be able to ...

Understand

- the importance of limiting factors and tolerance limits in population distributions



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Understand

is defined as to know the meaning of something or to grasp the situation;

present remembered ideas, facts or experiences;

Becoming familiar with the idea that …

A knowledge of limiting factors and tolerance limits is important in understanding population distributions





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Questions

What is a limiting factor?

- Give an example of its importance

What a tolerance limit?

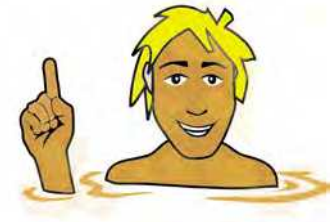
- Give an example of its importance

What is Shelford's law?

- How is it relevant when discussing tolerance limits?

What is Leibig's law?

- How is it relevant when discussing limiting factors?



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Definitions

A tolerance limit is the upper and lower limit to the range of particular environmental factors (e.g. light, temperature, availability of oxygen, water) within which an organism can survive.

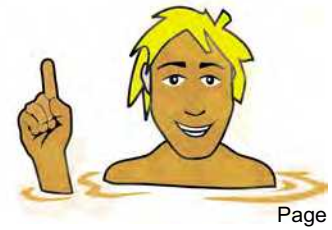
Organisms with a wide range of tolerance are usually distributed widely, while those with a narrow range have a more restricted distribution.

A limiting factor is a component of an ecosystem which limits the distribution or numbers of a population.

A limiting factor defines optimal survival conditions according to its effect on a species when in deficiency or excess.

Limiting factors can be either biotic (living) or abiotic (non-living).





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Tolerance limits

Just as species have geographic ranges, they also have tolerance ranges for the abiotic environmental conditions. In other words, they can tolerate (or survive within) a certain range of a particular factor, but cannot survive if there is too much or too little of the factor.

Take temperature, for example.

King penguins survive very well in low temperatures, but would die from overheating in the tropics.



King penguin colony

Photo ANARE reproduced with permission

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On the other hand, a saltwater crocodile does very well in the heat of the tropics, but would quickly freeze to death in the Antarctic.



Saltwater crocodile

Photo Ian Morris

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These examples point out that different types of organisms have different tolerance ranges for the same factor.

Temperature

Exceptions are when animals hibernate, life cycles go into dormancy or reptiles (such as saltwater crocodiles) are limited by water temperatures.



Photo Ian Morris

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The tolerance range of a single individual may also change over time.

For example - Salmon

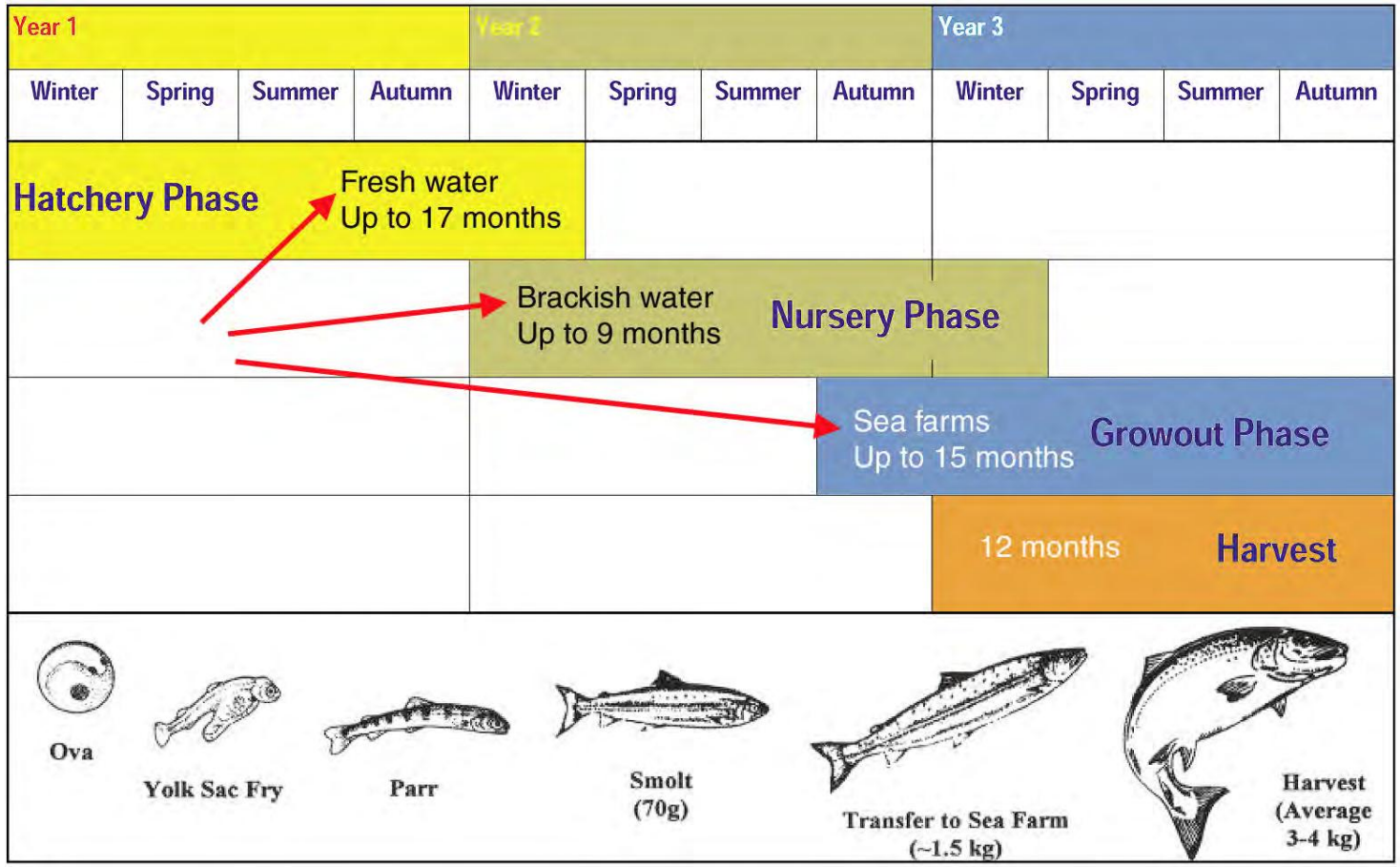


Adult Salmon

Photo Ruth Fairley reproduced with permission

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They start life in a freshwater stream, migrate out to the open ocean, and then come back to their home stream to reproduce.



Salmon life cycle

Illustration After Tassal

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So salmon can tolerate huge changes in salinity and temperature during their life cycle.





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Other organisms, such as some species of fish, have low tolerances to temperature and salinity and die.



Dead fish
Photo Tim Ryan

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Fish kills are often the first visible signs of environmental stress.

If it is a cold-related stress, juvenile fish or species that are not cold-tolerant may be selectively affected.

If toxicity is the cause, species are more generally affected and the event may include amphibians and shellfish as well.

If it dissolved oxygen it may affect larger fish more than smaller fish.

So lets have a look at how oxygen impacts on tolerance limits.



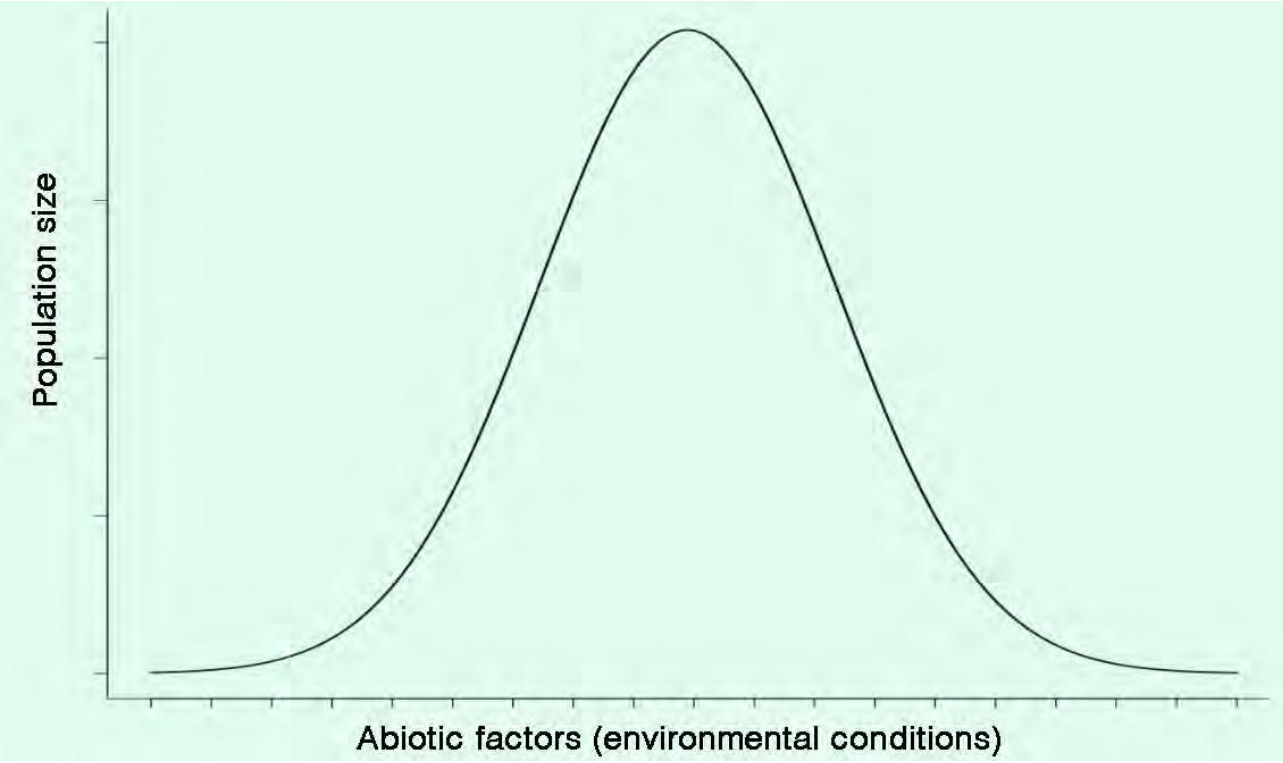
Fish kill

By United States Fish and Wildlife Service. [Public domain], via Wikimedia Commons

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If we draw a graph of how many individuals in a population live under which part of the range of any given factor, you almost always get a bell-shaped curve.

The horizontal axis could be any of the abiotic factors (environmental conditions) and the vertical axis for population size.



Bell curve with abiotic factors

Illustration Bob Moffatt

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Let’s look at oxygen levels as the limiting factor and compare two fish populations:

Silver Perch and a Rainbow Trout.



Silver perch



Rainbow Trout

Silver perch and Rainbow Trout

© State of New South Wales through NSW Department of Industry

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You would go out and measure the oxygen level of every place where you find the silver perch and also count how many silver perch are in each habitat.

When you make a graph of your data, it might look like Graph 1.

Graph 1 Oxygen toleration range v's number of individuals

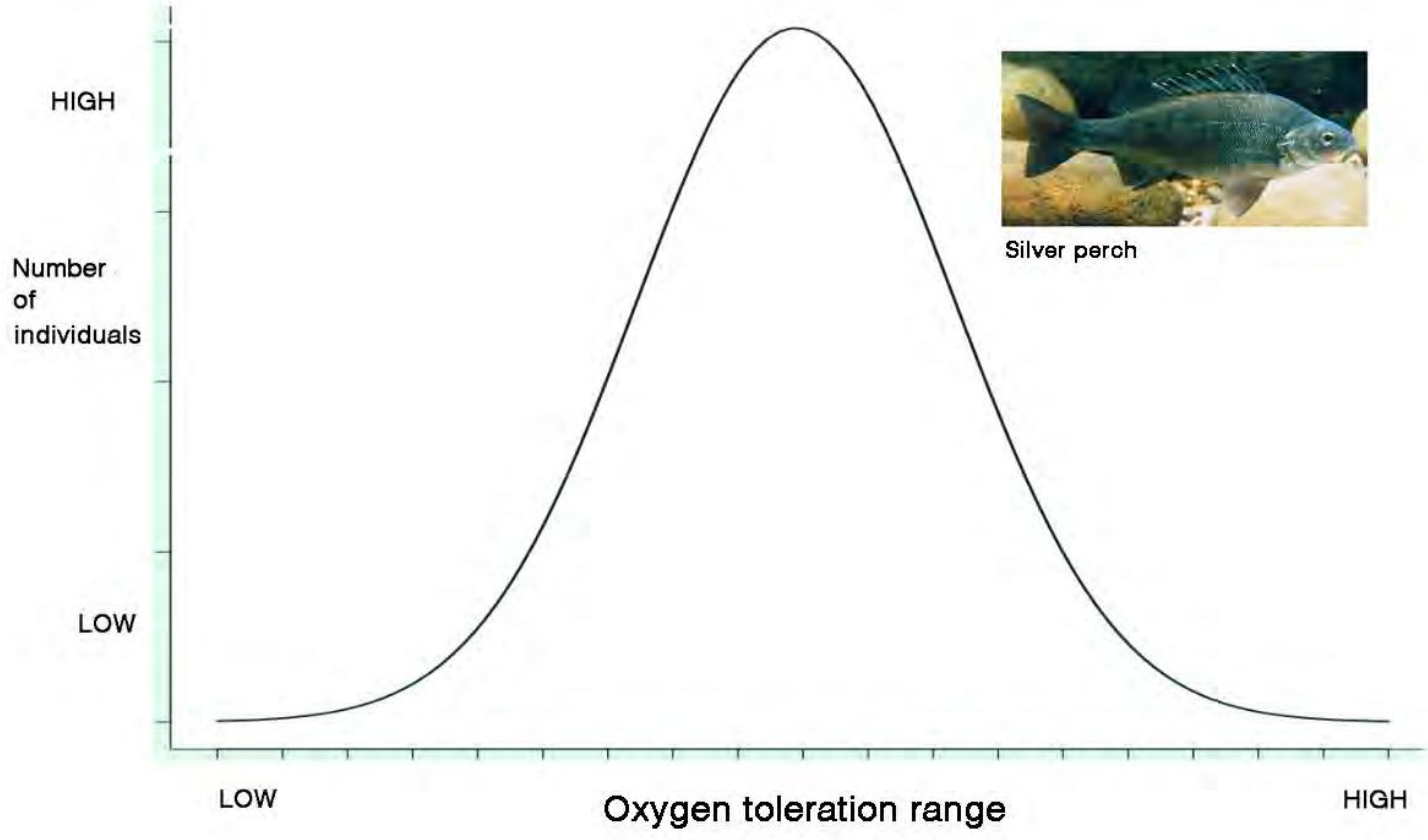


Illustration Bob Moffatt

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This graph is telling you that the majority of the Silver perch live in the middle part of the oxygen range; that's where the curve is highest.
As you move from the middle part to lower oxygen levels (to the left) or to higher oxygen levels (to the right), the curve is not as high – there are fewer individuals that live in habitats that have the lower or higher amounts of oxygen.

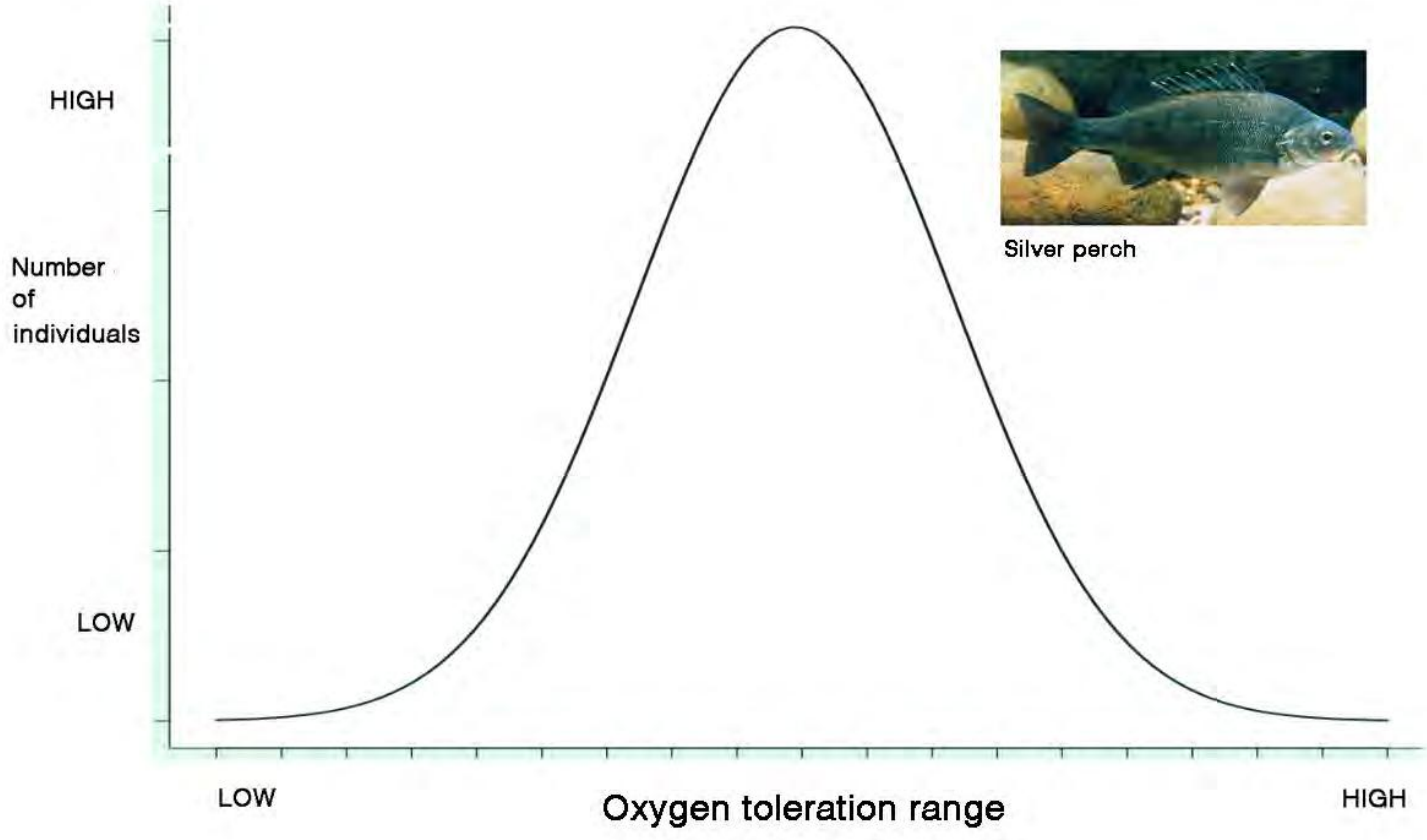


Illustration Bob Moffatt

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If the oxygen level is extremely low or high, it is beyond the tolerance range of the species and no silver perch live in those habitats.



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Now take a look at Graph 2, which represents the oxygen tolerance range curve for the rainbow trout.

Graph 2 Oxygen toleration range v's number of individuals

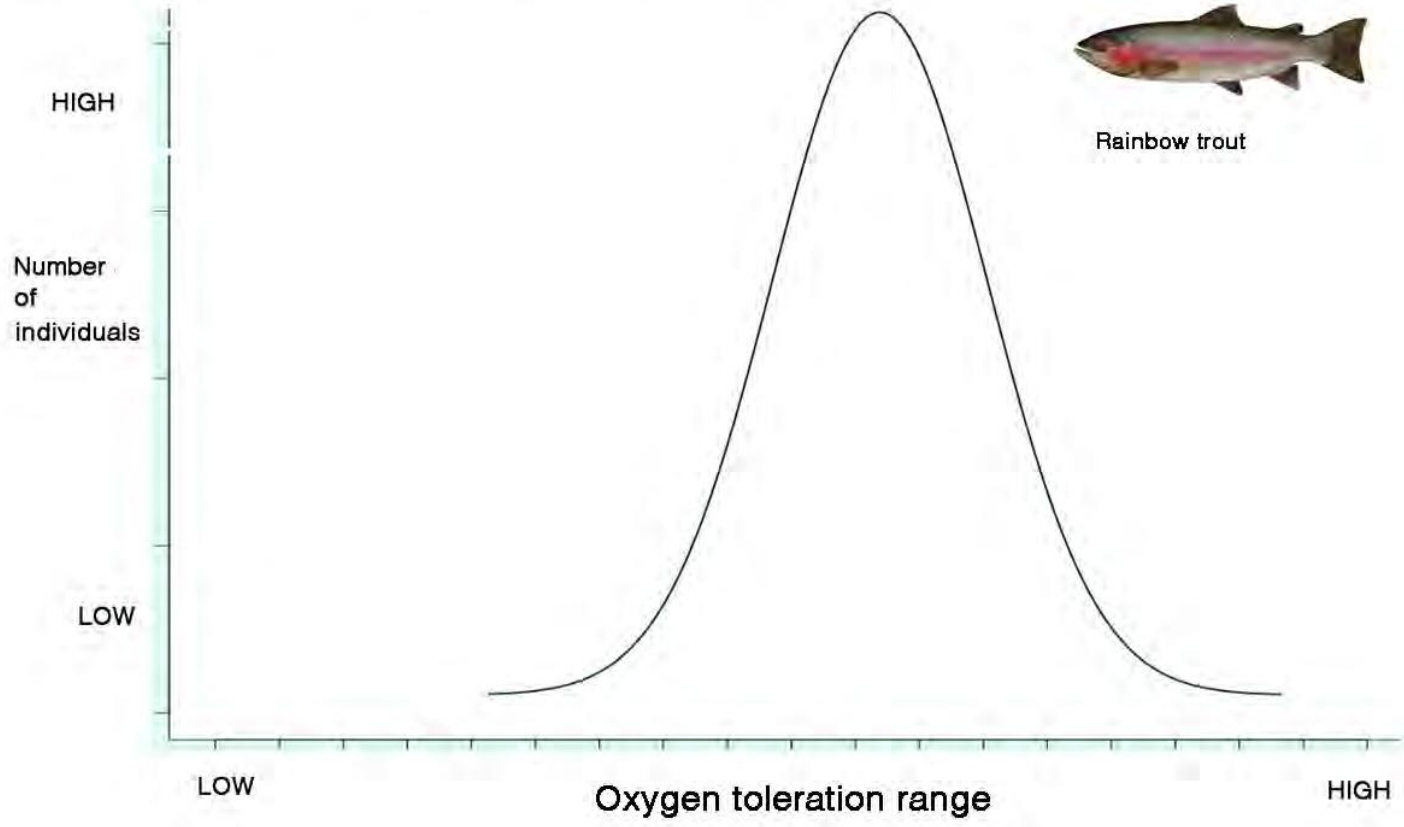


Illustration Bob Moffatt

© Wet Paper Publications

This is telling us that rainbow trout have a much narrower tolerance range for oxygen than silver perch.



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Rainbow trout can only survive and thrive in a narrow band of oxygen levels, so you would expect that its geographical range would be more restricted.

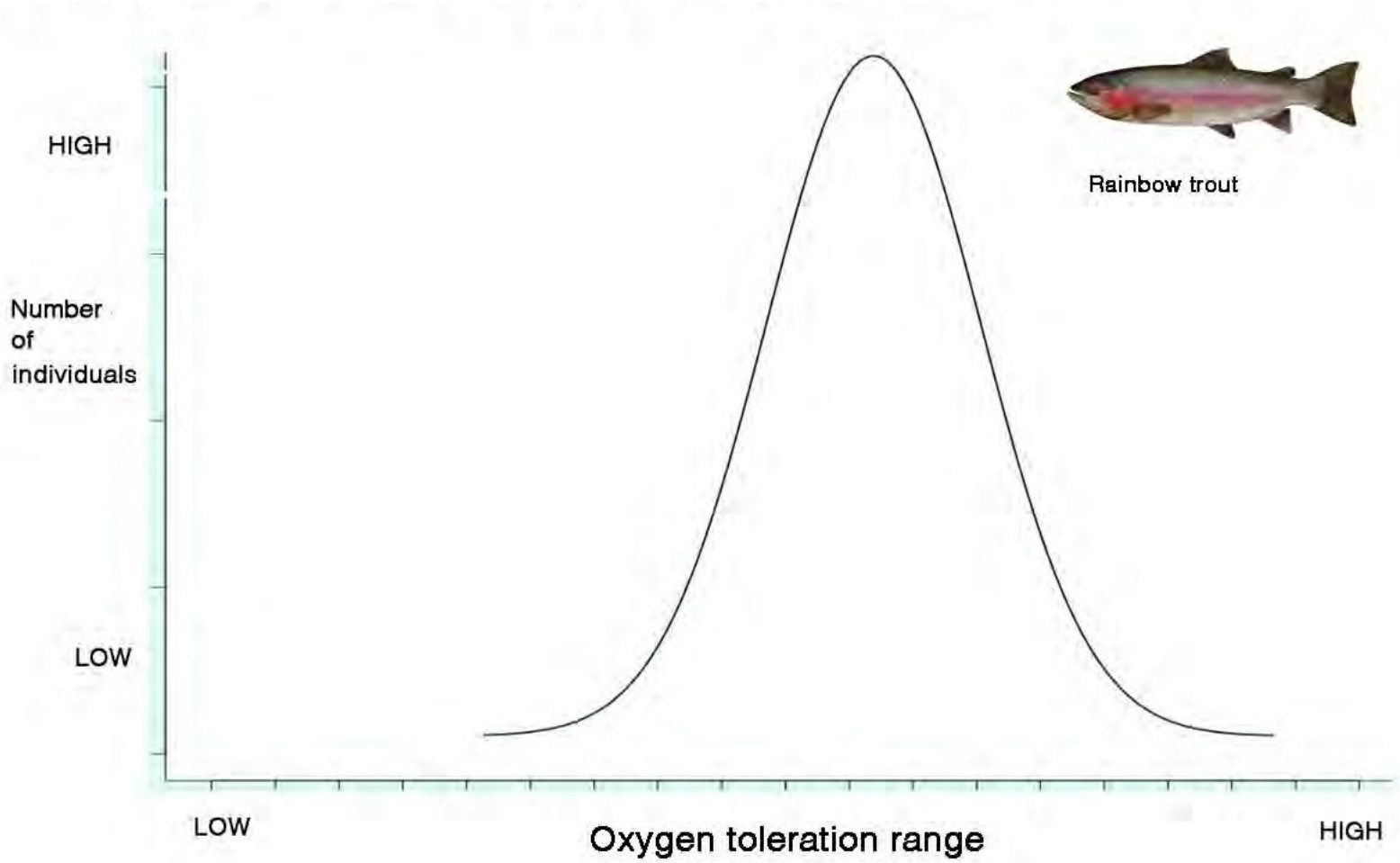


Illustration Bob Moffatt

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Rainbow trout would not be distributed as widely as the silver perch, since it wouldn’t do well in stagnant areas with lower oxygen levels.



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If you look closely, you'll also notice that the peak of the curve for the rainbow trout is a little bit to the right of the peak of the curve for the silver perch.

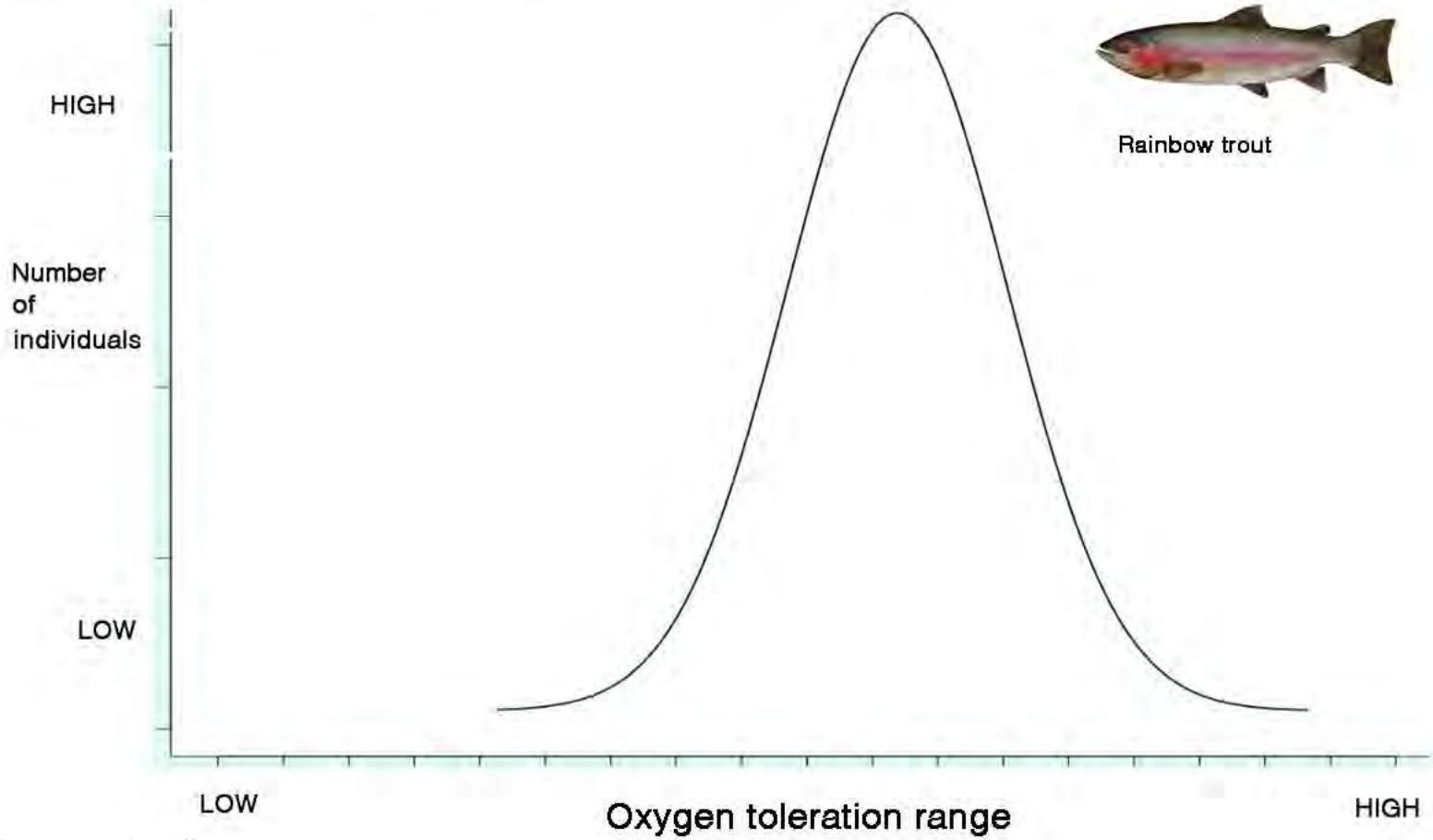


Illustration Bob Moffatt

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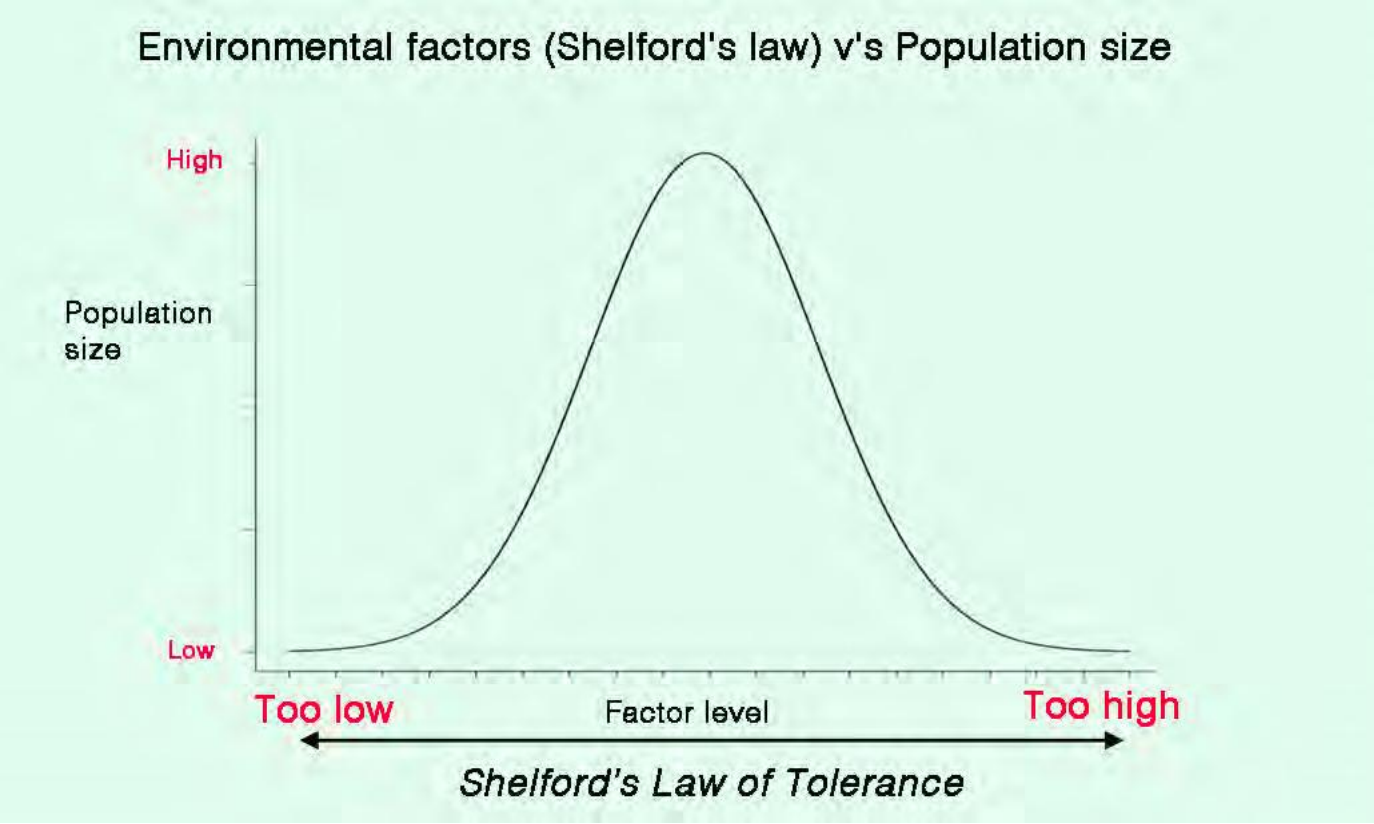
This tells us that compared to Silver perch, Rainbow Trout do best in water that is slightly more oxygenated.



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These bell shaped curves can be introduced to explain Shelford's Law of Tolerance.

This states that <u>for every organism, there is an optimum in regard to environmental factors</u>.



Environmental factors (Shelford's law) v's Population size

Illustration Bob Moffatt

© Wet Paper Publications

When environmental factors are not favourable

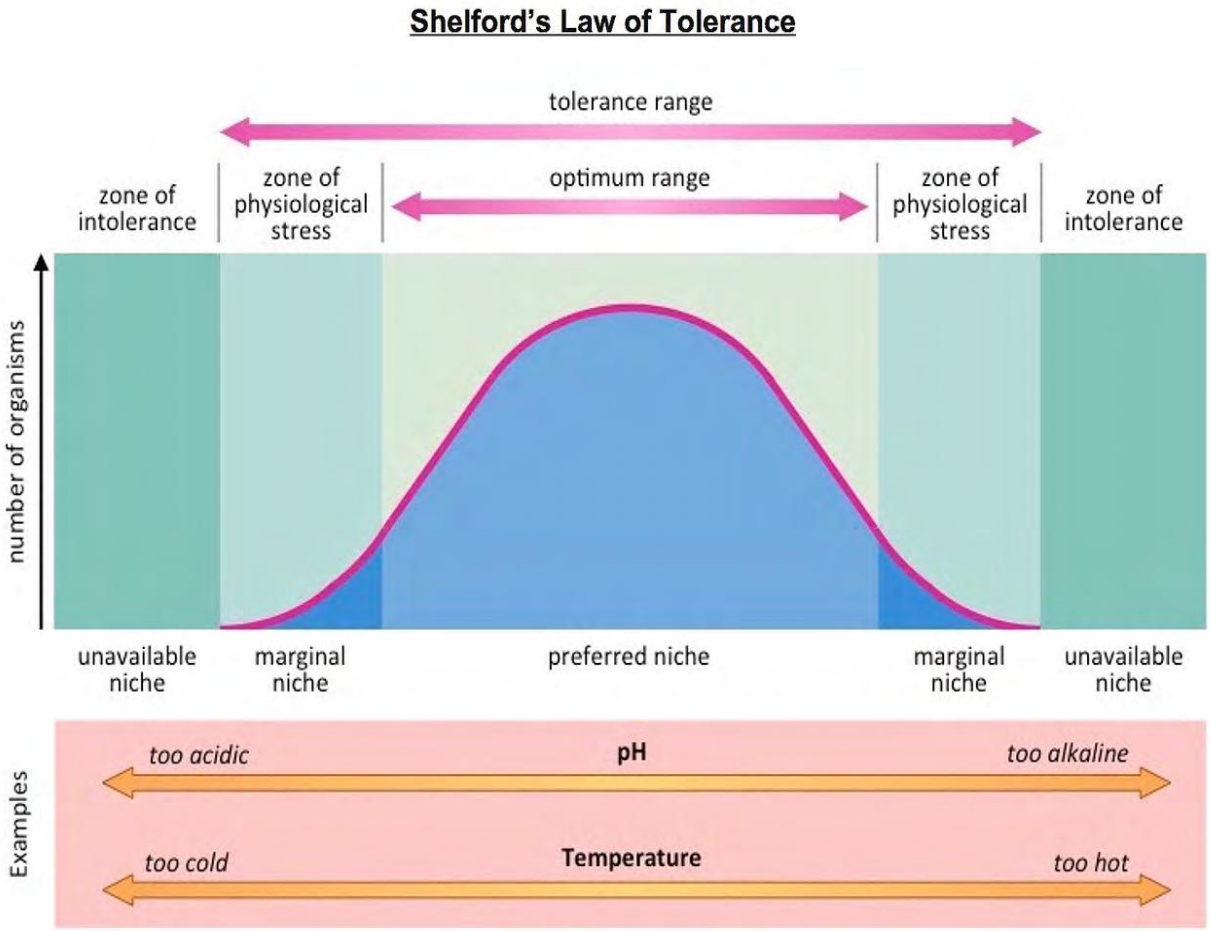
eg too low or too high

- the number of individuals will decrease.



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Marine scientists have taken the graph further to include the bell-shaped curve with 3 distinct regions.



Optimal zone – Central portion of curve which has conditions that favour maximal reproductive success and survivability.

Zones of stress – Regions flanking the optimal zone, where organisms can survive but with reduced reproductive success.

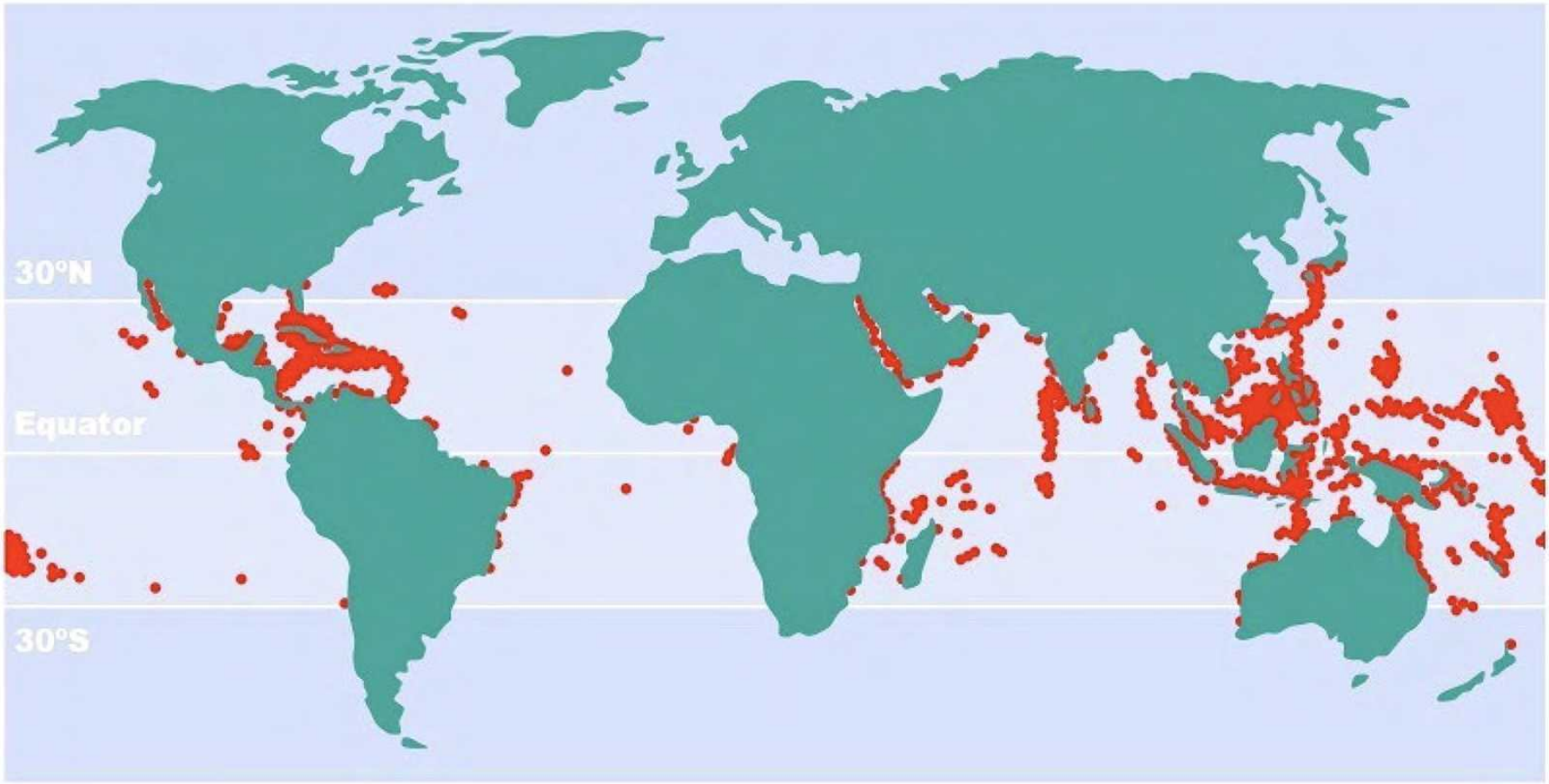
Zones of intolerance – Outermost regions in which organisms cannot survive (represents extremes of the limiting factor).

Shelford's law with three zones of tolerance

From: http-//ib.bioninja.com.au/options/option-c-ecology-and-conser/c1-species-and-communities/survival-factors.html.jpg

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Next year you will study corals which live in specific temperature ranges.



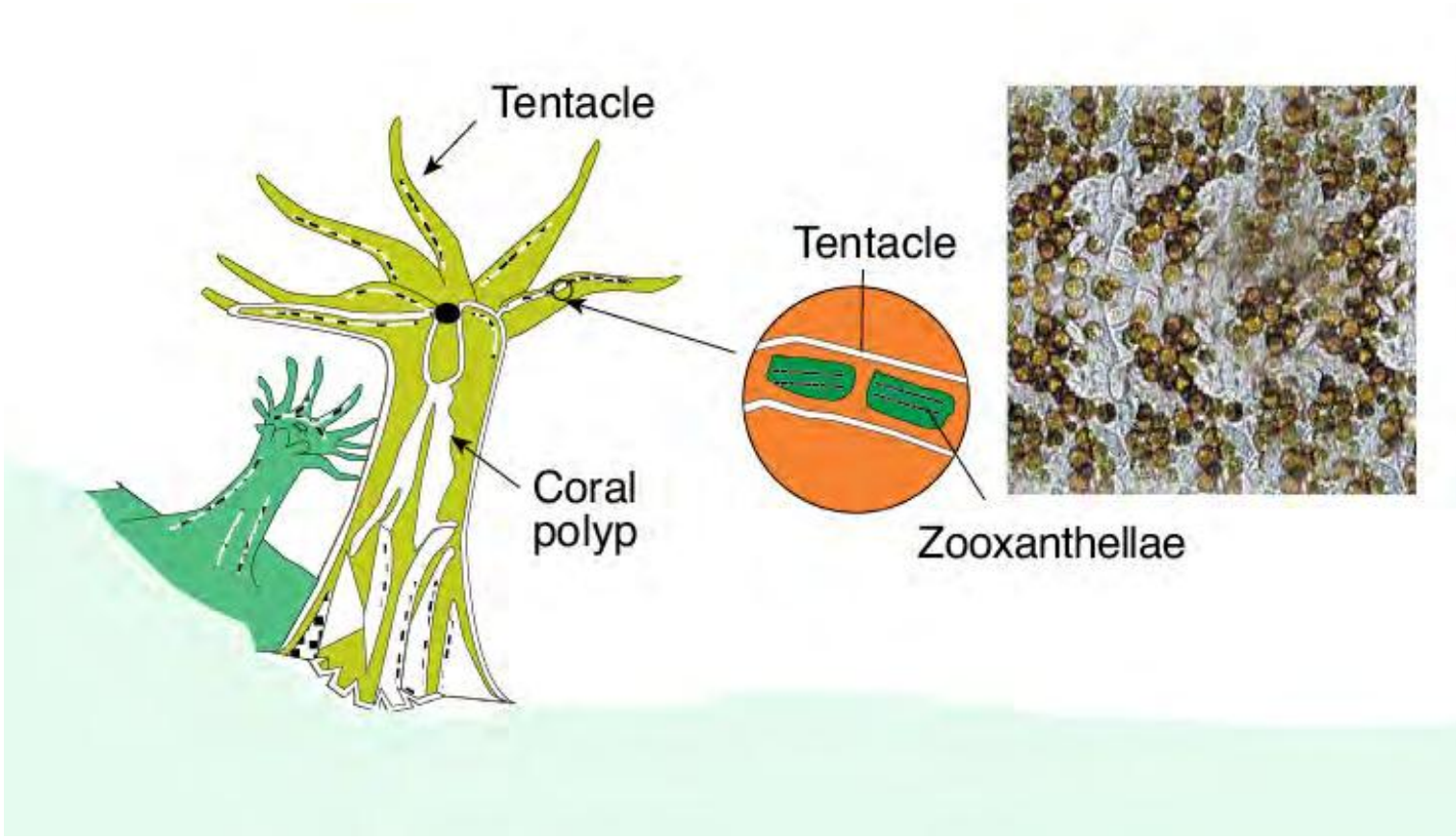
Global distribution of coral reefs

Credit: http-//ib.bioninja.com.au/options/option-c-ecology-and-conser/c1-species-and-communities/survival-factors

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Coral polyps receive nutrition from photosynthetic zooxanthellae (an algae) that lives within the polyp's endodermis.

The zooxanthellae cannot survive in lower ocean temperatures (i.e. < 18ºC).



Zooxanthellae and coral

Illustration Bob Moffatt Photo CSIRO reproduced with permission

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Increases in ocean temperature cause zooxanthellae to leave the coral tissue, leading to coral bleaching (i.e. > 35^0C).

Reef-building coral species therefore have a typical optimal growth range in temperate waters between 20 – 30^0C.

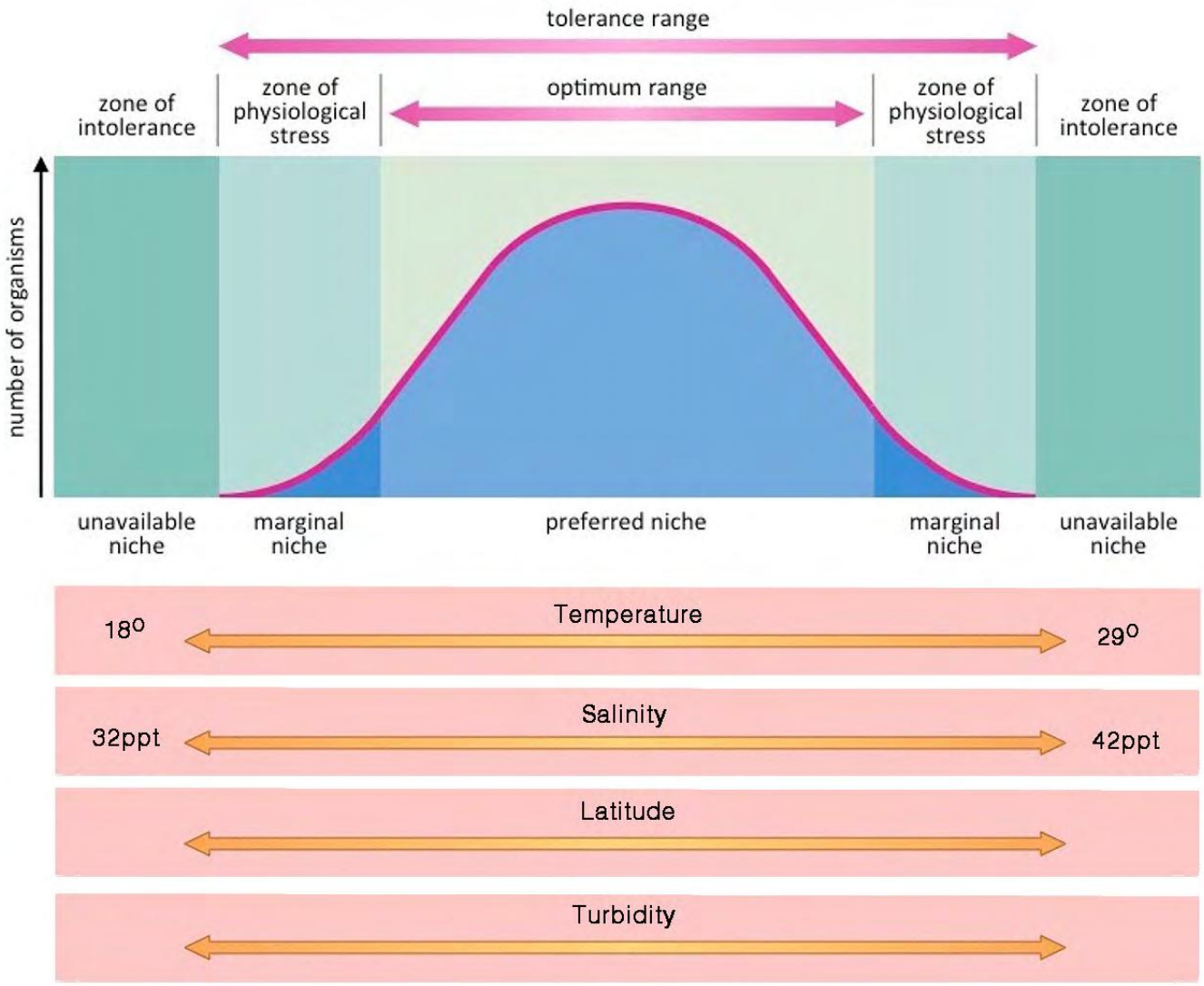


Coral bleaching

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We can use the bell curve to explain the concept of coral bleaching in terms of Shelford's law of tolerance



Shelford's law graph and coral bleaching

Illustration Bob Moffatt and http-//ib.bioninja.com.au/options/option-c-ecology-and-conser/c1-species-and-communities/survival-factors.html.jpg

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Limiting factors

In ecology, a limiting factor is a component of an ecosystem which limits the distribution or numbers of a population.

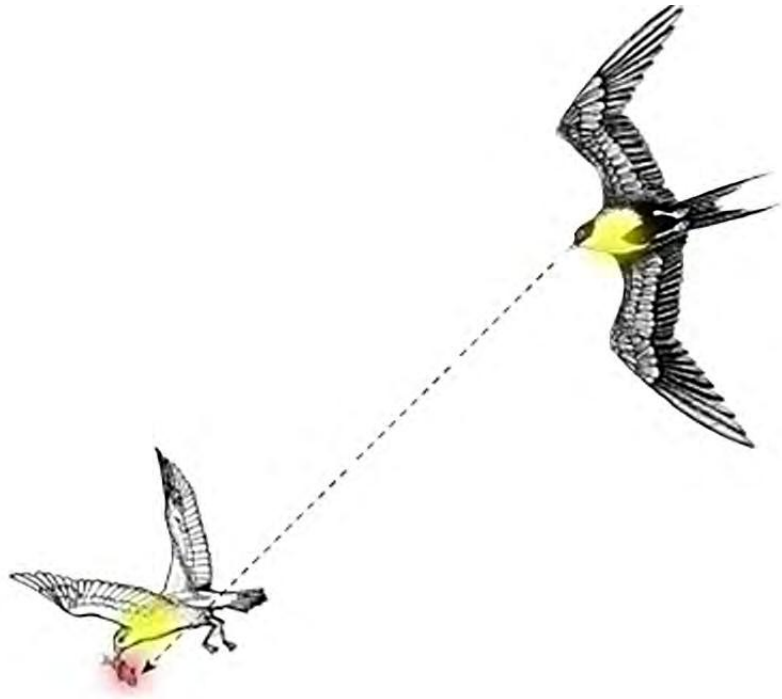
A limiting factor defines optimal survival conditions according to its effect on a species when in deficiency or excess.

Limiting factors can be either biotic (living) or abiotic (non-living).



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Biotic factors include interactions between organisms – either within species (for example competition) or between species (for example predator-prey, parasitism).



Birds stealing food

Illustration Kerry Kitzelman

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Abiotic factors include environmental conditions – such as:

light, temperature, salinity, rainfall, wind velocity, pH, oxygen, cyclone waves, flood sediments.



Sediment runoff at a river entrance

Photo Paula Moffatt

© Wet Paper Publications

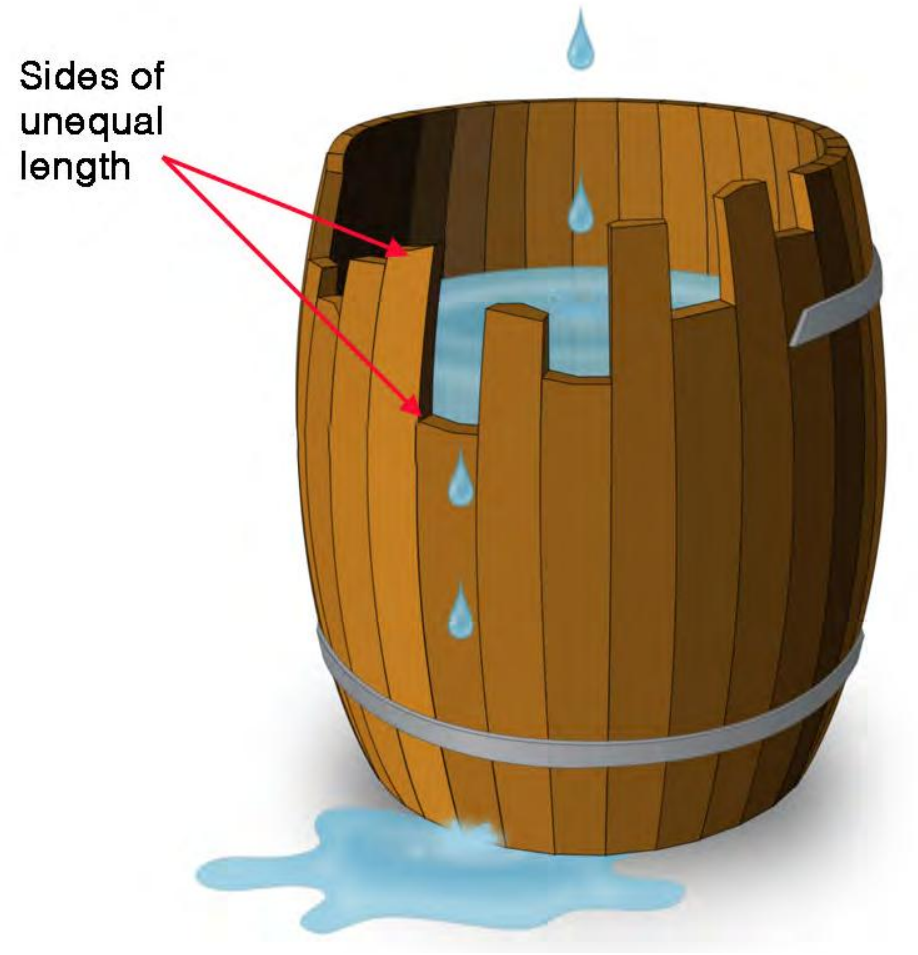
Liebig's Law of the Minimum seeks to explain how these limiting factors impact on population numbers

This states that growth of a population is controlled not by the total amount of resources available, but by the scarcest resource.



© Wet Paper Publications

Most explanations of the law use a barrel with unequal sides, filled with water.



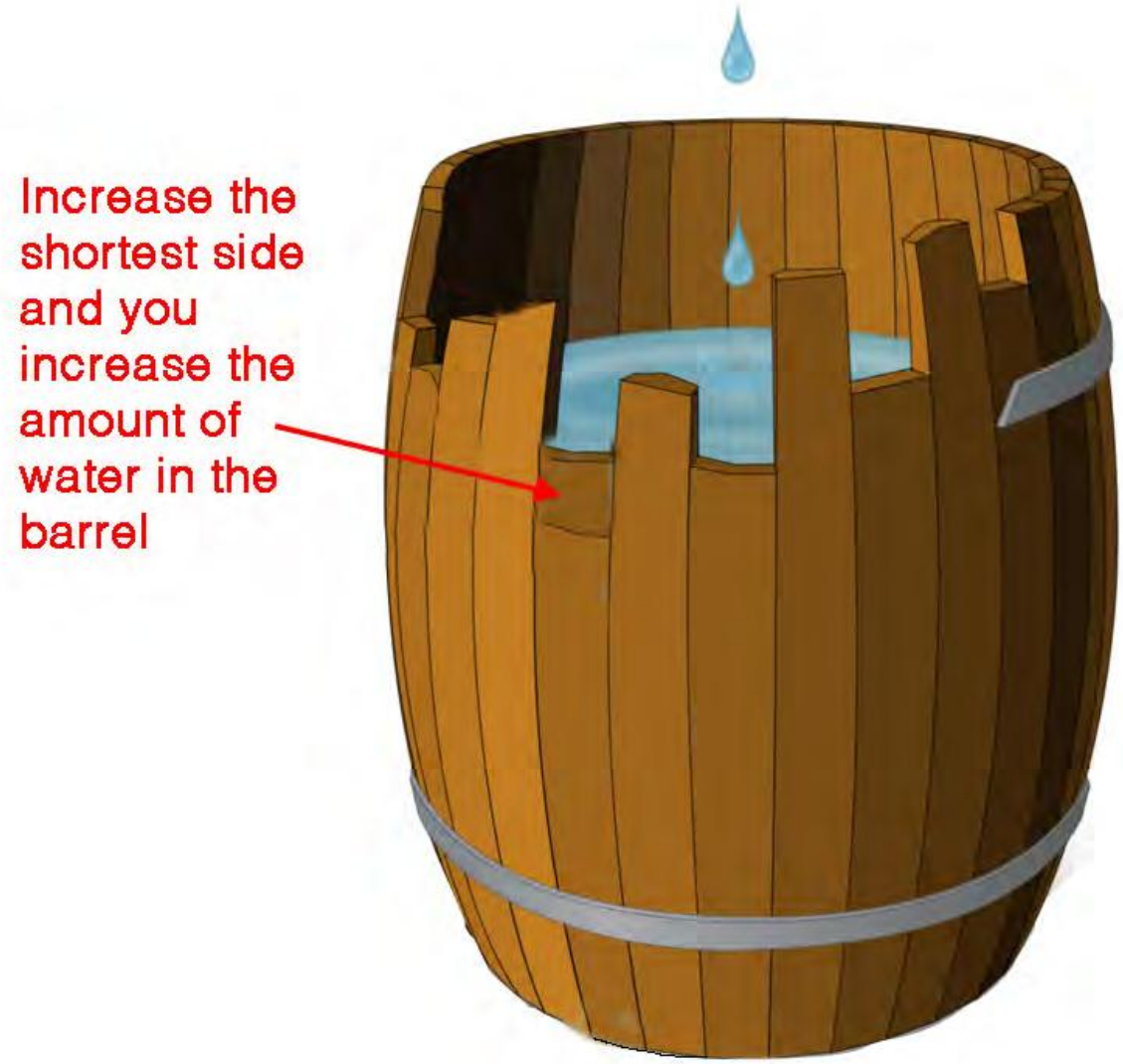
Leibigs barrel showing unequal sides

By DooFi (Own work) [Public domain], via Wikimedia Commons

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The limiting factors for the amount of water the barrel can hold is the shortest side.

Increase the shortest side and the barrel holds more water.



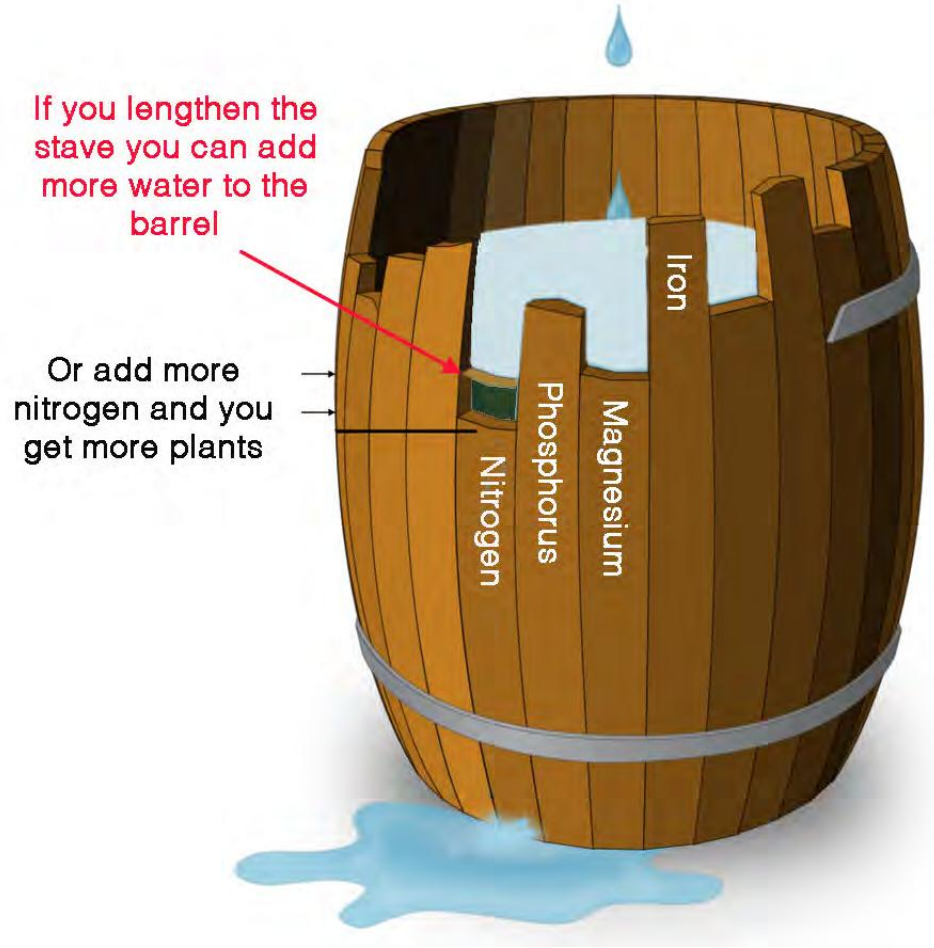
Leibig's barrel shortest
By DooFi (Own work) [Public domain], via

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Liebig's argued that a plant's growth is limited by the nutrient in shortest supply.

If we call the sides nitrogen, phosphorus, iron and magnesium, we could get more plants by adding more nitrogen.

So the limiting factor was nitrogen.



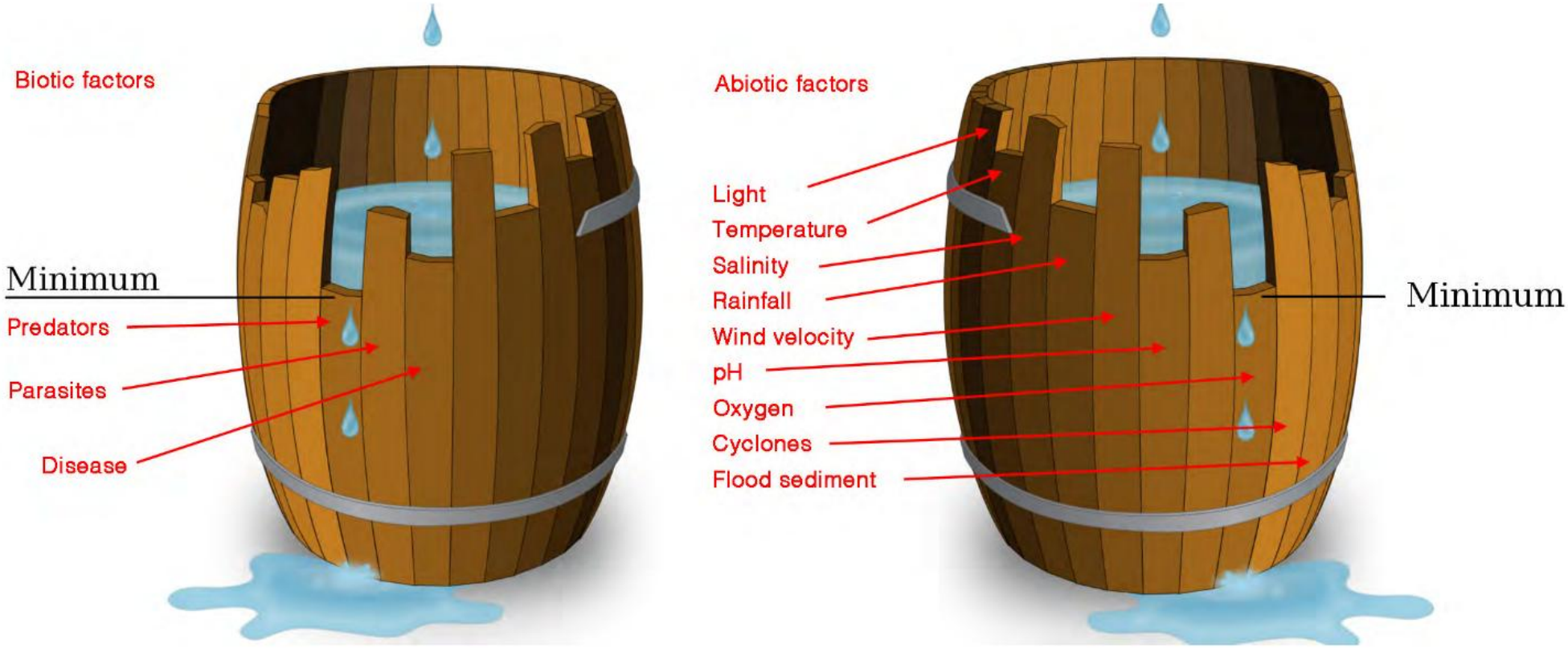
Leibigs barrel with increased nitrogen

By DooFi (Own work) [Public domain], via Wikimedia Commons and Bob Moffatt

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Can this be taken further?

We stated that limiting factors can be either biotic (living) or abiotic (non-living) so can we find examples of their potential to control population growth?



Leibigs barrel with abiotic and biotic factors

Illustration By DooFi (Own work) [Public domain], via Wikimedia Commons and Bob Moffatt

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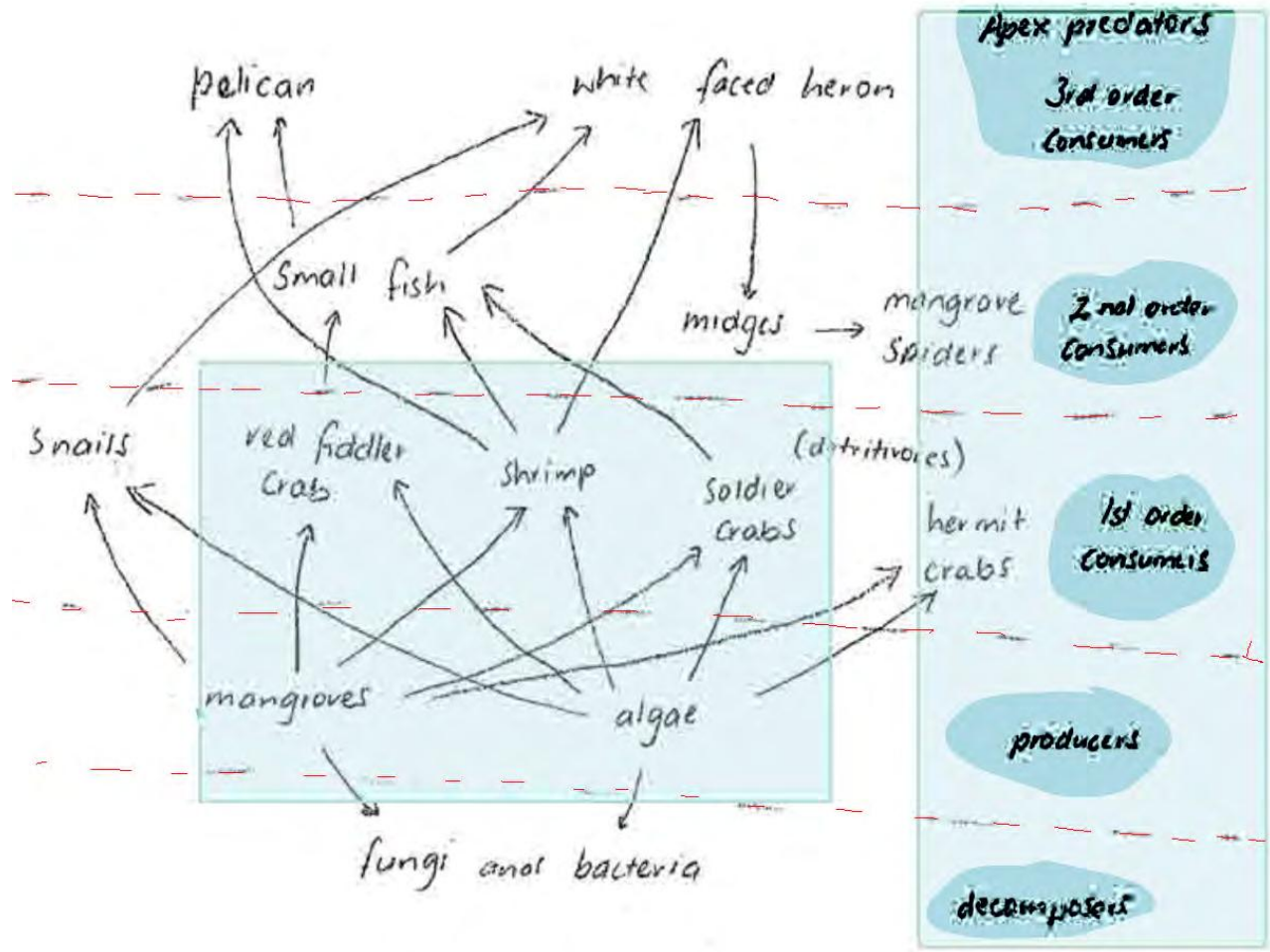
Can we apply this using a food web?

Although a given population may interact with many different species in a food web,

and

also interact with many different abiotic factors outside the food web,

not all of these interactions are of equal importance in controlling that population's growth.



Mangrove food web

From QCAA Author unknown Queensland student circa 2012

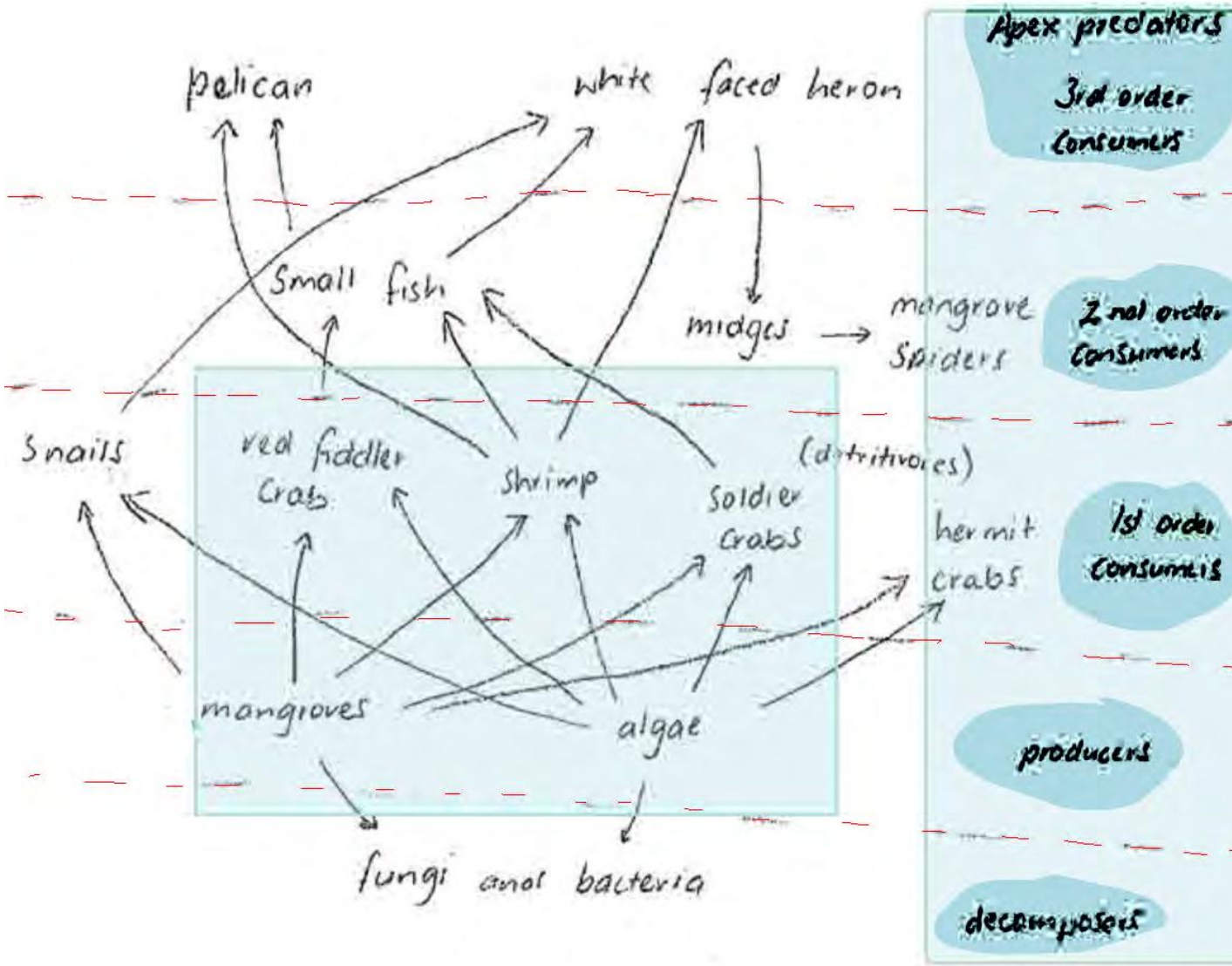
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A noted scientist Berryman in 1993 stated that

"only one or two other species dominate the feedback structure of a population at any one time and place."

The identity of these dominating species may change with time and location, but the number of species that limits a given population (i.e. actively controls its dynamics) is usually only one or two."

So which two species in the food web will control the food web?



Mangrove food web

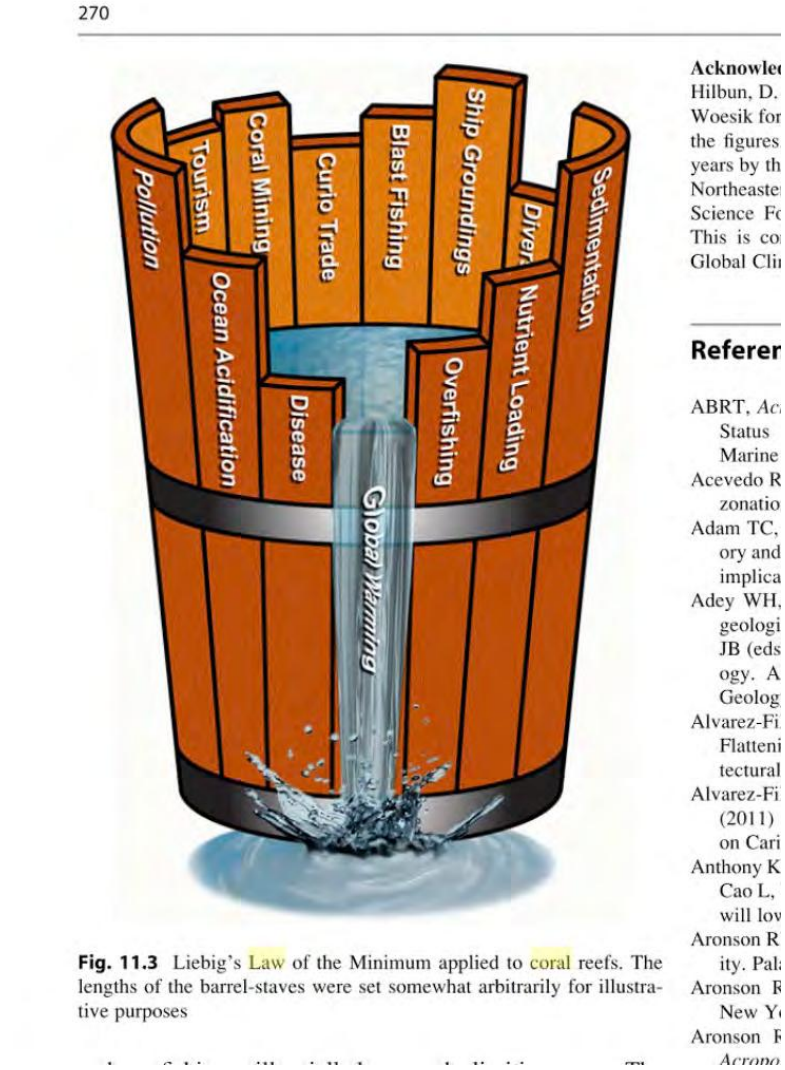
From QCAA Author unknown Queensland student circa 2012

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He argued that Liebig's Law, in its modern form, expresses this idea.

It says that of all the biotic or abiotic factors that control a given population, one has to be limiting (i.e. active, controlling the dynamics).

Time delays produced by this limiting factor are usually one or two generations long.



Leibigs law applied to coral reefs

After Coral Reefs at the Crossroads edited by Dennis K. Hubbard, Caroline S. Rogers, Jere H. Lipps, George D. Stanley, Jr.

© Wet Paper Publications

The classic paper on Liebig's Law of the minimum and plankton ecology has lead scientists to treat Leibig's law as a paradox:

- known to be an invalid argument but still valuable in promoting critical thinking.

De Baars original paper page 1

https://www.rug.nl/research/portal/files/14561526/1994ProgOceanogrdeBaar.pdf



Pergamon

Prog. Oceanog. Vol. 33, pp. 347-386, 1994
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0079-6611(94) 00007-7

von Liebig's Law of the Minimum and Plankton Ecology (1899-1991)

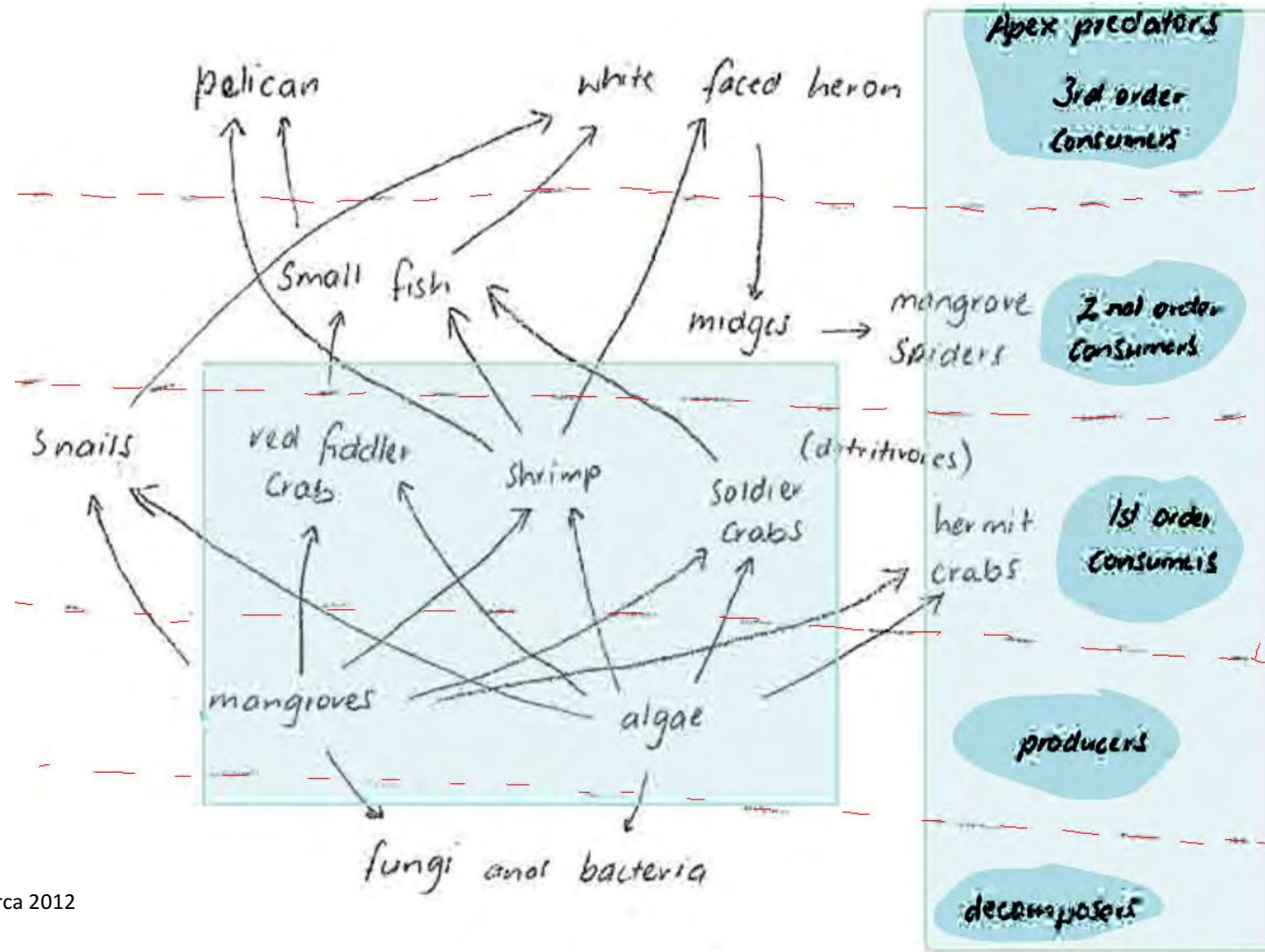
H.J.W. DE BAAR

Department of Marine Biology, University of Groningen, PO Box 14, 9750AA Haren, The Netherlands

Abstract – The Law of the Minimum was originally formulated by Justus von Liebig, as one of the 50 interlinked laws concerned with agriculture. The original writings of J. von Liebig often were misinterpreted by his successors. BRANDT (1899) took this one law out of its context and proposed that limitation by nitrogen is a dominant factor in plankton ecology, far beyond its original application to agriculture. This was opposed by NATHANSOHN (1908) who suggested instead a dynamic balance of growth and loss terms. Towards validating, or eventually falsifying Brandt's hypothesis, Atkins, Harvey, Cooper and others developed the chemical methods necessary for re-defining ocean nutrient cycling and growth limitation. The major exception to these modern perspectives was the Antarctic Paradox of high nutrients and low chlorophyll which inspired Gran, Atkins, Harvey and Cooper to pioneer the concept of iron limitation. An exhaustive overview is given of efforts to define Fe in seawater and its controlling effect on *in situ* plankton growth, for the 1920-1984 period. Somewhat parallel work in the laboratory on single species of algae in chelation-controlled media has provided much insight, but is sketched only briefly. Martin and contemporaries developed the chemical methods necessary for defining the ocean chemistry of Fe and its role for *in situ* growth. These developments are sketched for the 1982-1991 period. Once again the Law of the Minimum and associated bold hypotheses served, albeit briefly, to bring a nutrient element in the forefront of research. This, and the recent awareness of CO_2 as rate limiting factor, underline the conclusion that advances in sciences often hinge on advances in technology, confirming KUHN (1962). In this case the new analytical techniques developed by Atkins, Harvey, Cooper, Martin and their associates have proven revolutionary for plankton ecology. Some observations in plankton ecology may be reminiscent of the agricultural Law of the Minimum, but this would not warrant its direct application, beyond its original context and agriculture, to plankton ecology. Rather the net rate of increase of phytoplankton is the dynamic balance of multiple growth and loss terms, together also determining the biomass at given time and space.

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So, when you come to make a study during this semester, consider Leibig's law as a starting point for a quantitative study on what you think the limiting factors are.



Mangrove food web

From QCAA Author unknown Queensland student circa 2012

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At the end of the day you are going to study a mangrove, reef or rocky shore ecosystem. The question is:-

Is there a limiting factor that has to be present in sufficient qualities, that allows the biodiversity in an ecosystem to be maintained?



Google Earth

© Wet Paper Publications

Certificate of understanding hereby awarded to

for becoming familiar with the idea that

A knowledge of limiting factors and tolerance limits is important in understanding population distributions

© Wet Paper Publications



T054 Assess tolerance limit data

With Artemia experiment

Bob Moffatt

© Wet Paper Publications

The syllabus says

assess

data to identify an organism's tolerance limit





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Assess

to measure, determine, evaluate, estimate or make a judgment

about

the value, quality, outcomes, results, size, significance, nature or extent of something

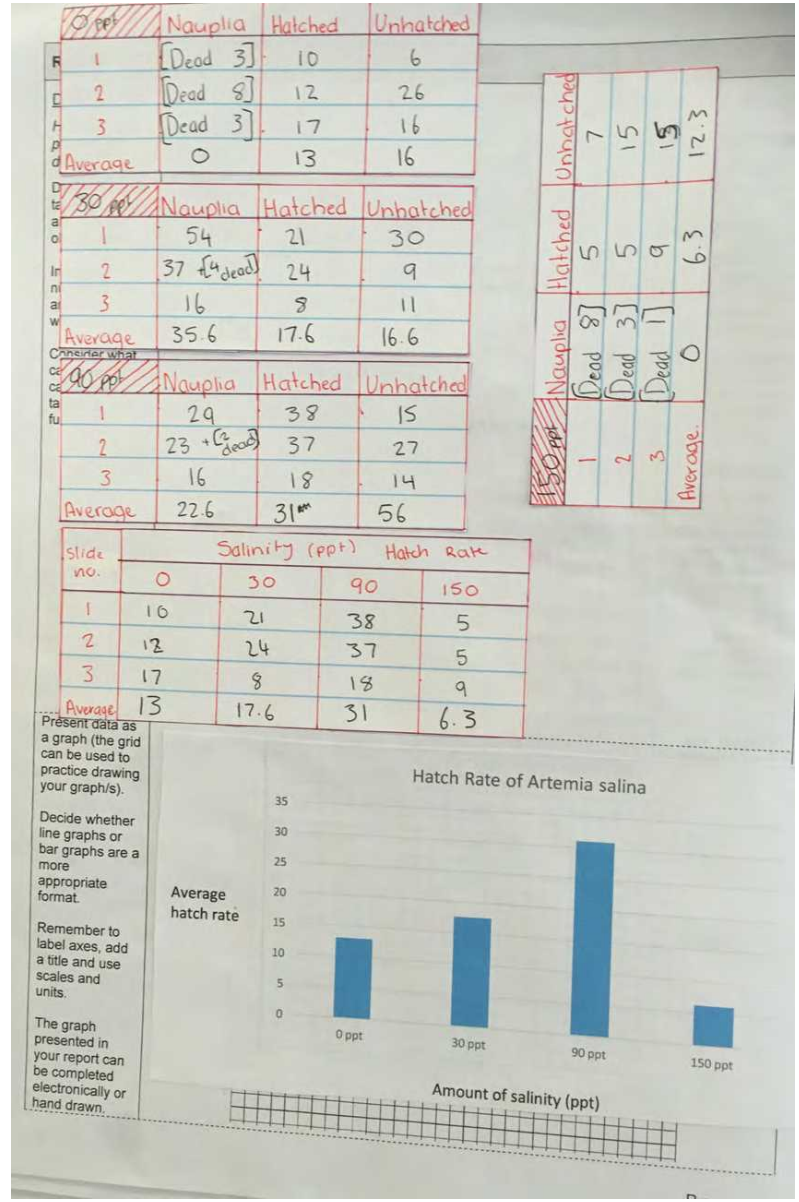




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Student experiment

To determine the effect of salinity on the hatching rate of Artemia salina.



0 ppt	Nauplia	Hatched	Unhatched
1	[Dead 3]	10	6
2	[Dead 8]	12	26
3	[Dead 3]	17	16
Average	0	13	16

30 ppt	Nauplia	Hatched	Unhatched
1	54	21	30
2	37 +[4 dead]	24	9
3	16	8	11
Average	35.6	17.6	16.6

90 ppt	Nauplia	Hatched	Unhatched
1	29	38	15
2	23 +[3 dead]	37	27
3	16	18	14
Average	22.6	31	56

150 ppt	Nauplia	Hatched	Unhatched
1	[Dead 8]	5	7
2	[Dead 3]	5	15
3	[Dead 1]	9	15
Average	0	6.3	12.3

Slide no.	Salinity (ppt) Hatch Rate			
	0	30	90	150
1	16	21	38	5
2	12	24	37	5
3	17	8	18	9
Average	13	17.6	31	6.3

Present data as a graph (the grid can be used to practice drawing your graph/s).

Decide whether line graphs or bar graphs are a more appropriate format.

Remember to label axes, add a title and use scales and units.

The graph presented in your report can be completed electronically or hand drawn.

Student results PBC SHS

Acknowledgements

Mick O´Connor Ballina SHS

Danny Stevens Palm Beach SHS

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Research room

- Setting up for class experiments
- Building aquarium racks for water testing experiments

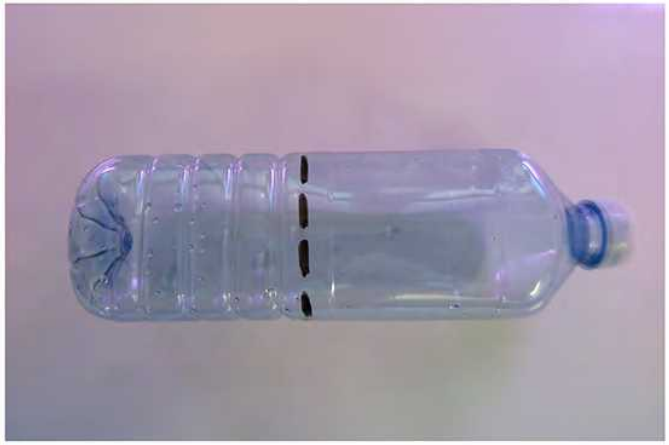


Danny Stevens and Danny Brentnall
PBC SHS
2018

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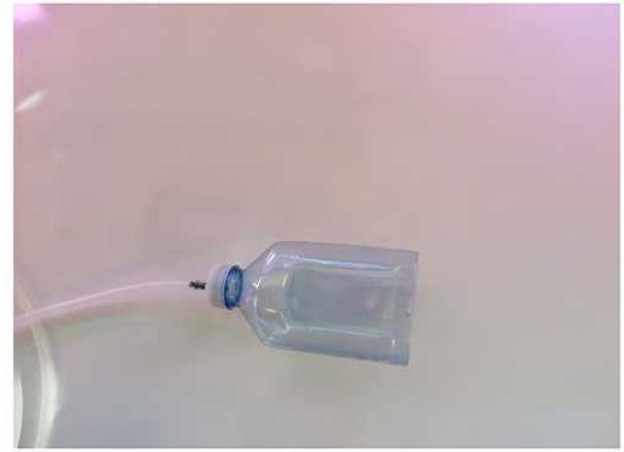
Equipment

Artemia for a two-day hatching experiment











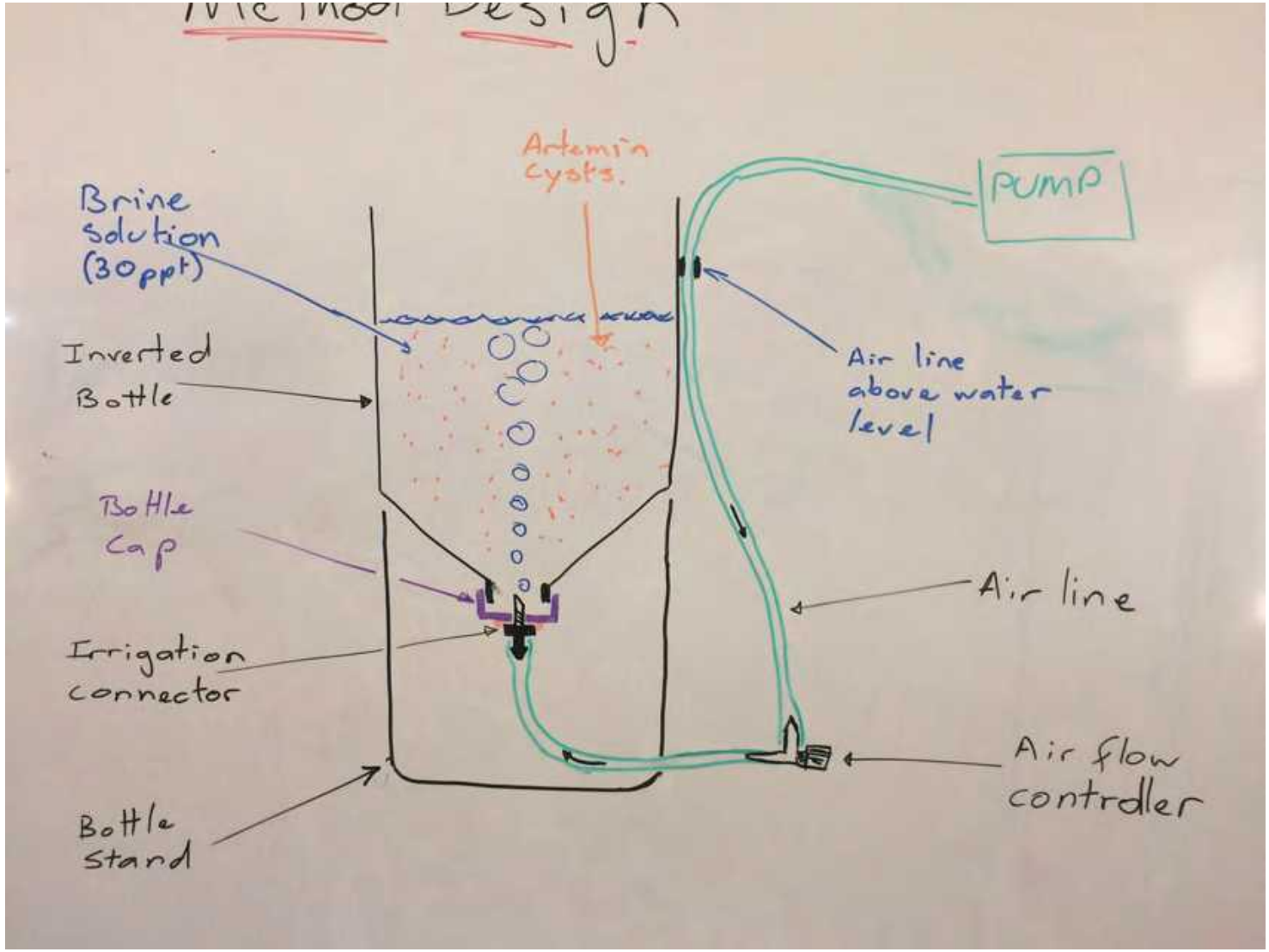




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Techniques

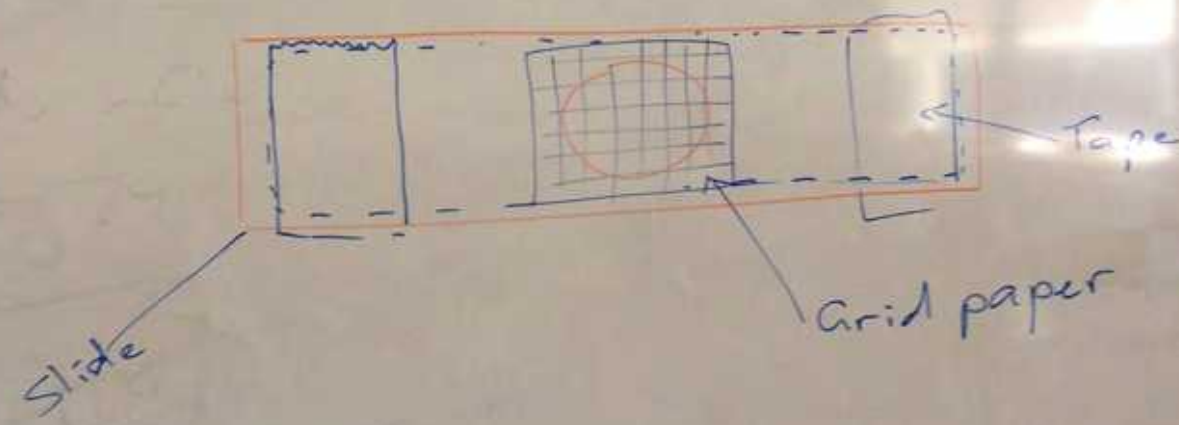


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Observing Artemia (wet mount)

A. Preping Slide

1. Find the well side of a slide
2. On the opposite side tape a grid behind



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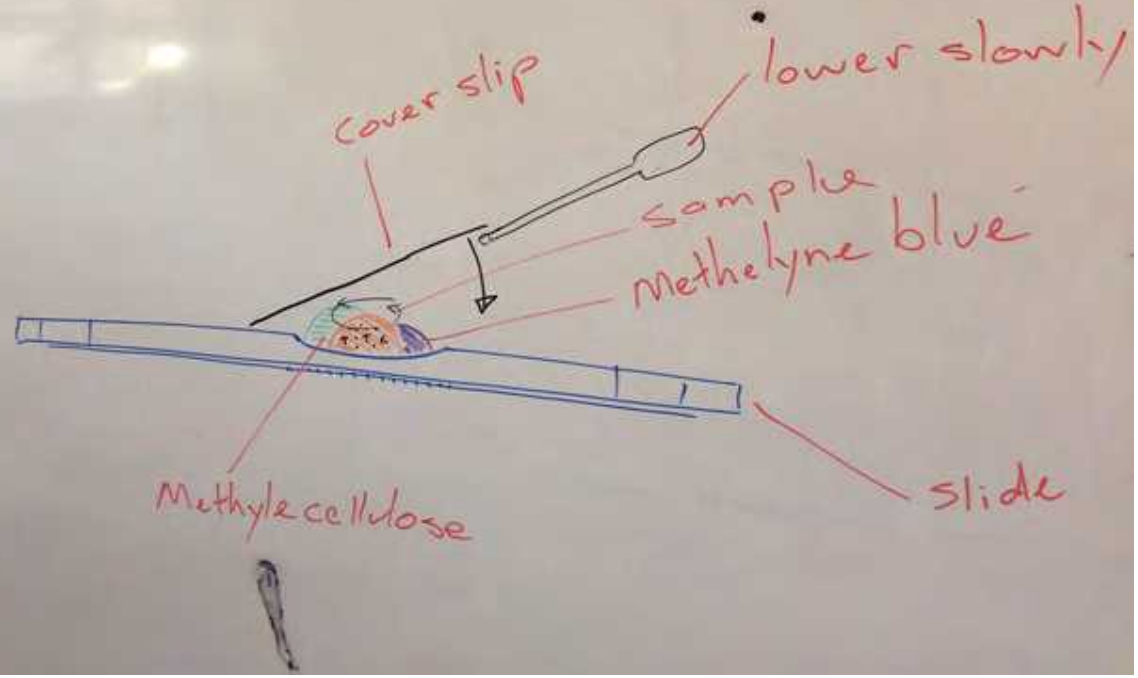
22/05/18

B Obtaining Sample

① Disconnect air line (Don't let water drain out)
② Stir the hatcher with your pipette → To distribute the Artemia evenly
③ Take a very small sample from the middle of the hatcher.

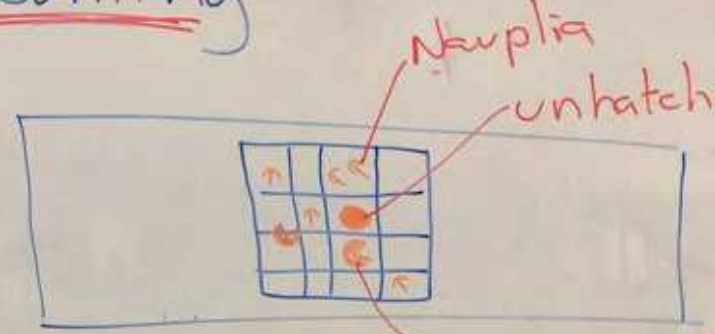


C Wet-mount



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Counting



Results

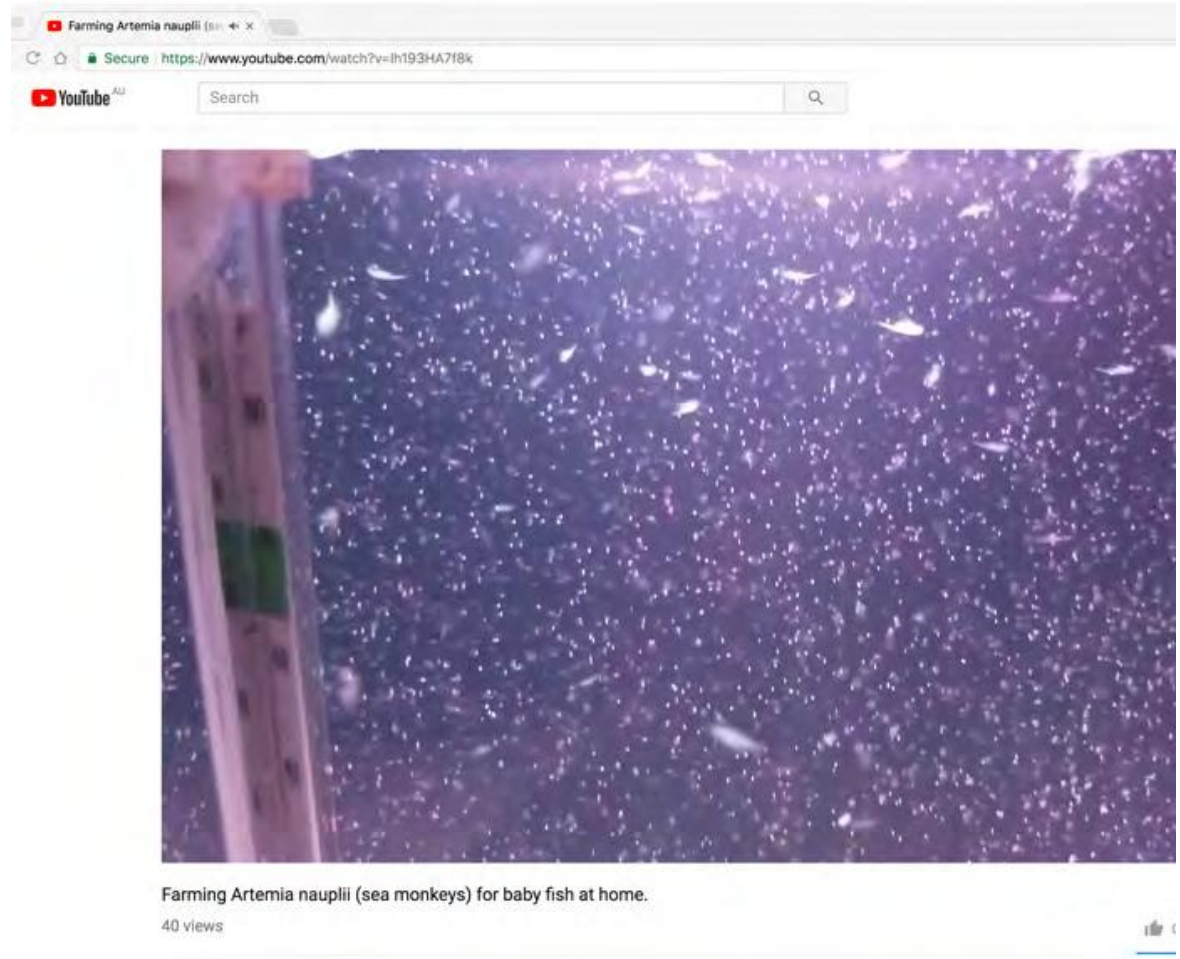
SLIDE	Nauplia		Hatched	Unhatched
1	IIII II	7		
2				
3				

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Introduction

This experiment uses Artemia brine shrimp as the organism on which data will be collected and assessed.

So what do they look like?



Watch the video
https://www.youtube.com/watch?v=Ih193HA7f8k

A youtube search set of words is
Farming Artemia nauplii (sea monkeys) for baby fish at home.

© Wet Paper Publications

The scientific name for brine shrimp is Artemia salina.

They live in isolated bodies of salt water and feed on microscopic organisms such as algae, yeast, and bacteria.

They are also bred as a food supply for a multitude of marine animals and aquaculture farms.



Artemia breeding ponds

By Doc Searls [CC BY-SA 2.0 (https://creativecommons.org/licenses/by-sa/2.0)], via Wikimedia Commons

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Brine shrimp are aquatic crustaceans less than 1cm in length.

Their bodies have wings along their sides with eleven pairs of appendages that undulate and act as paddles.



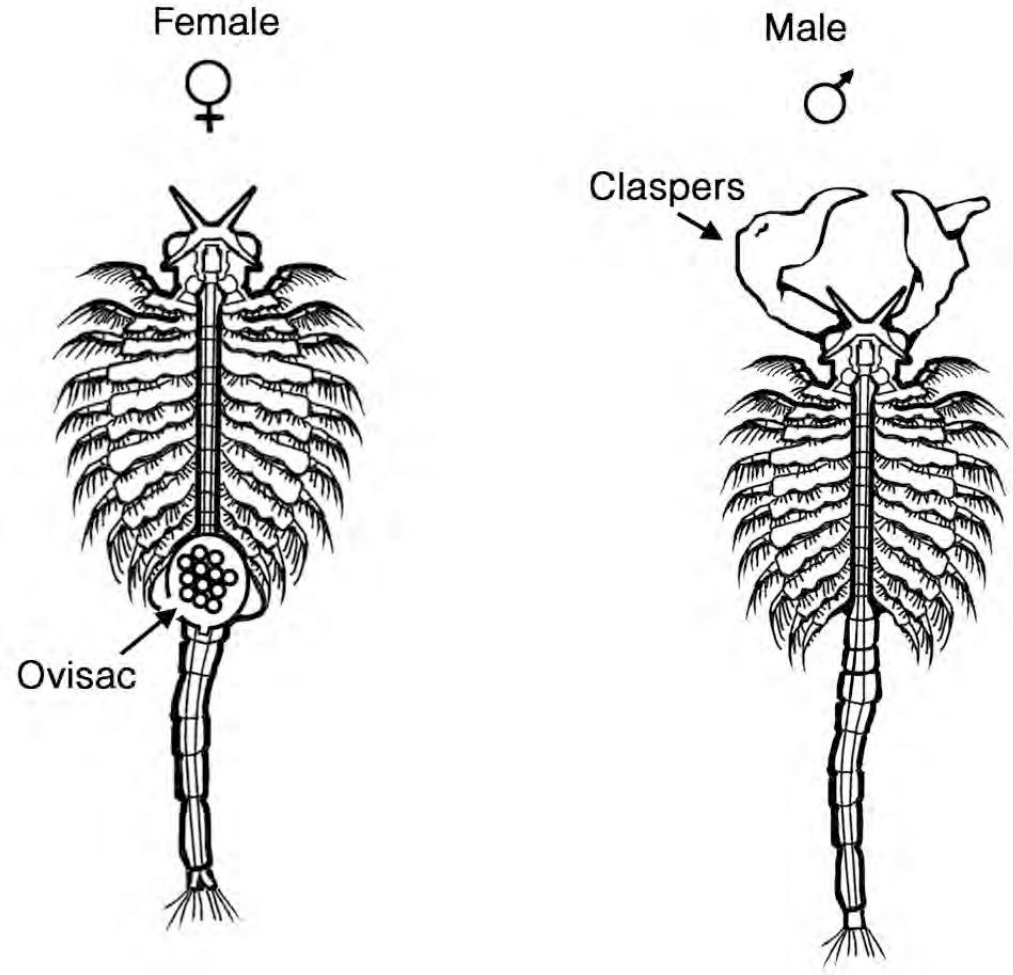
Artemia adult

Photo © Hans Hillewaert / , via Wikimedia Commons

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Males differ from females by having the second antennae markedly enlarged, and modified into clasping organs used in mating.

Adult female brine shrimp ovulate approximately every 140 hours.

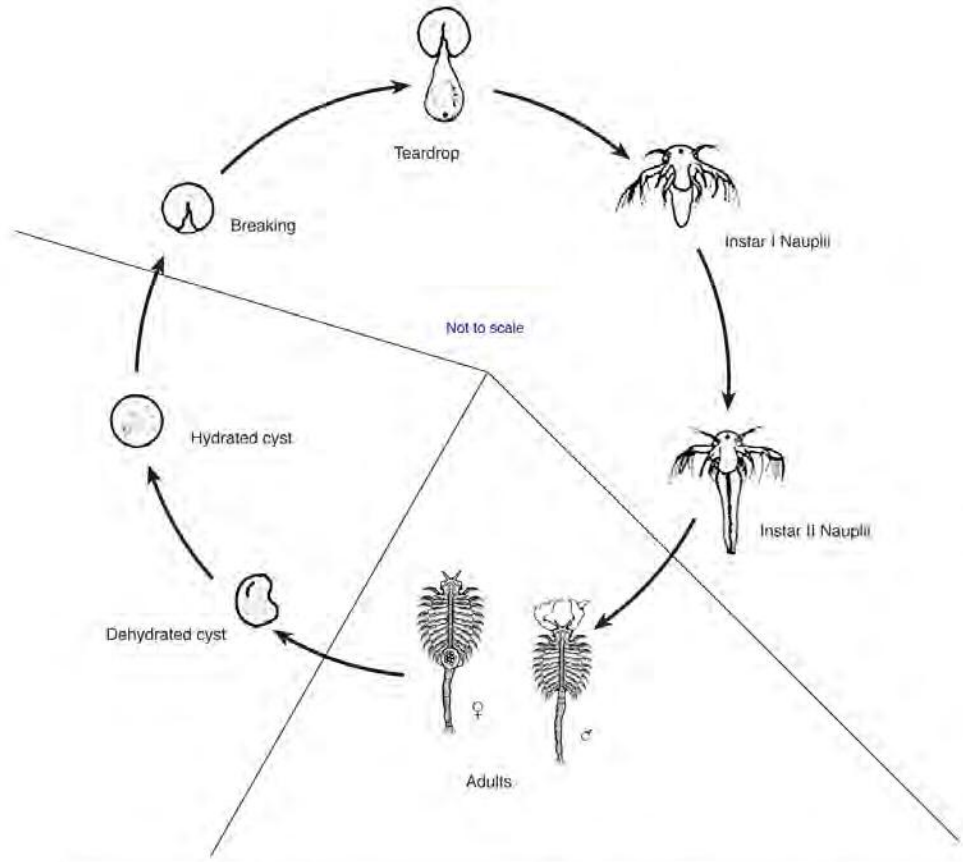


Artemia female and male

Illustration Kerry Kitzelman

© Wet Paper Publications

The life cycle of an Artemia begins with the hatching of cysts which are encased embryos that can stay in their dormant state for years if kept dry.



Artemia life cycle

Illustration Bob Moffatt

© Wet Paper Publications

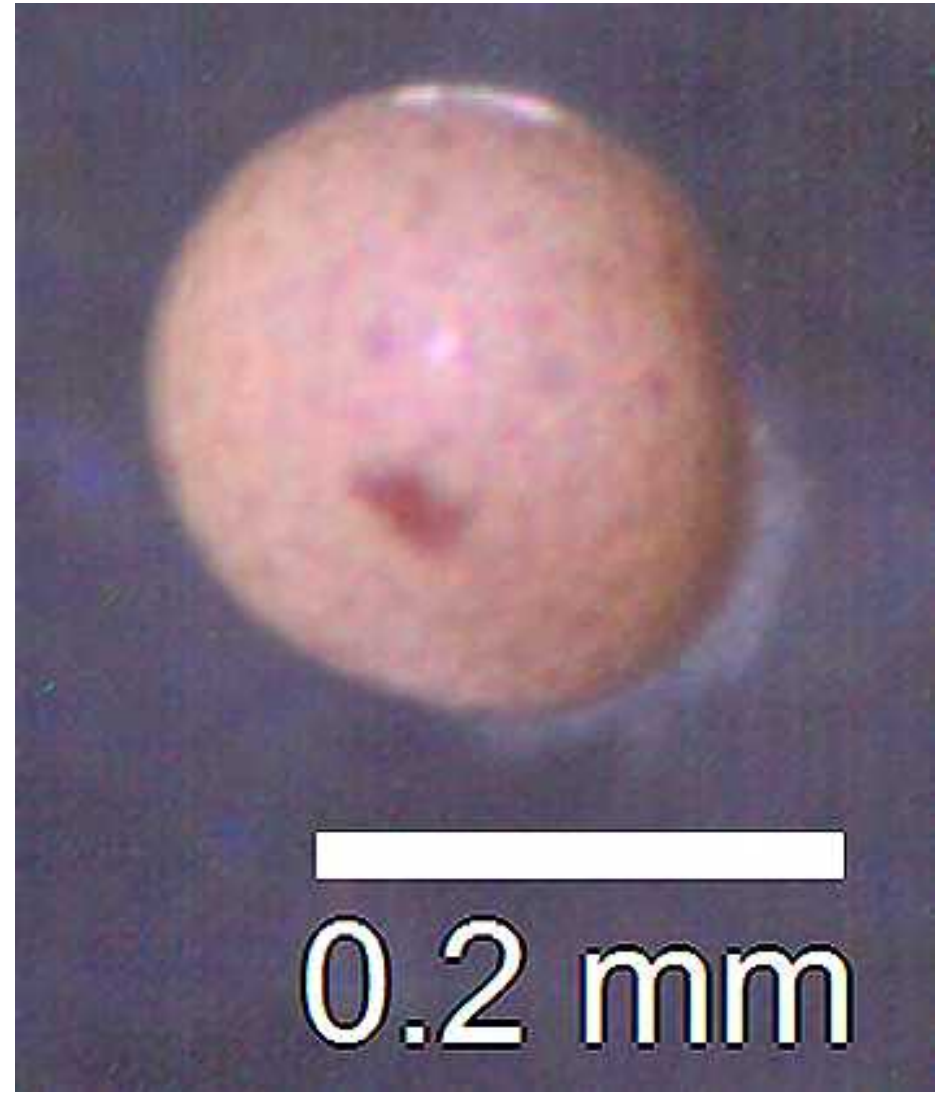
In extreme conditions, such as low oxygen level or salinity above 150‰, female brine shrimp produce eggs with a chorion coating which has a brown colour.

These eggs, also known as cysts.

You can read more about cryptobiosis at

https://en.wikipedia.org/wiki/Brine_shrimp

So that you could use it in your experimental discussion on global warming.



Artemia cyst

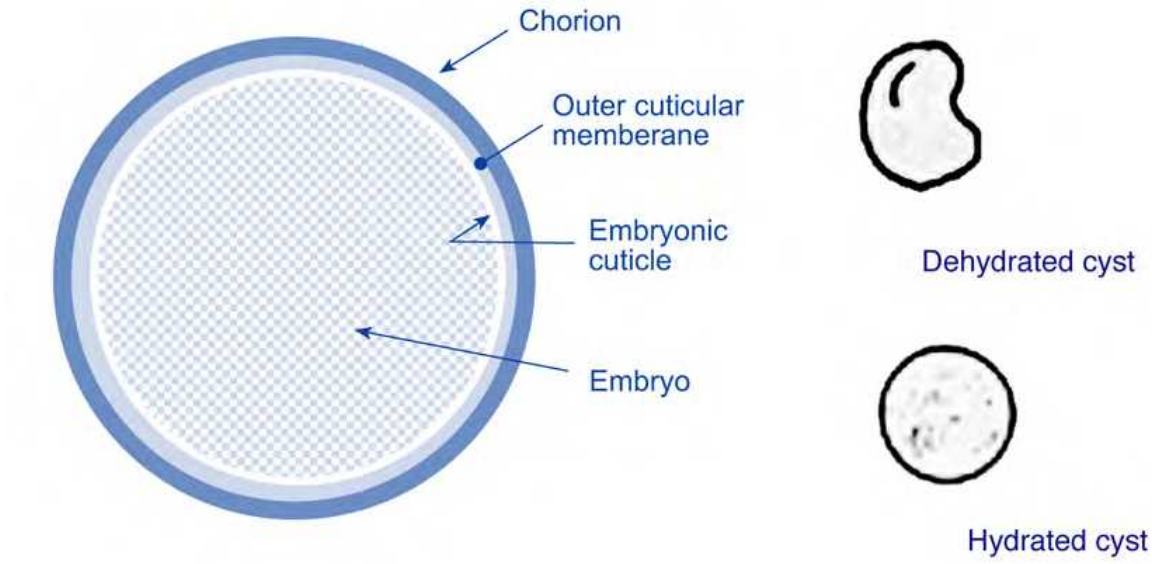
Photo By Adrian J. Hunter (Own work) [CC BY-SA 4.0 (https://creativecommons.org/licenses/by-sa/4.0)], via Wikimedia Commons

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Artemia cysts can stay dormant for long periods of time and can be easily hatched.

The chorion, also known as the 'capsule', is a shell made up of lipoproteins reinforced with haematite (iron ore) which gives the cyst its brown colour.

The outer cuticular membrane is directly under the chorion and allows the movement of small molecules only such as O_2, H_2O and CO_2.



Artemia cyst structure

Illustration Bob Moffatt

© Wet Paper Publications

It is this indigestible shell that causes gut problems when eaten by many fish larvae.

This must be removed before the ‘egg’ will hatch.

It can be removed by oxidising it with a 2.6% sodium hypochlorite solution without affecting the embryo in a process known as decapsulation.



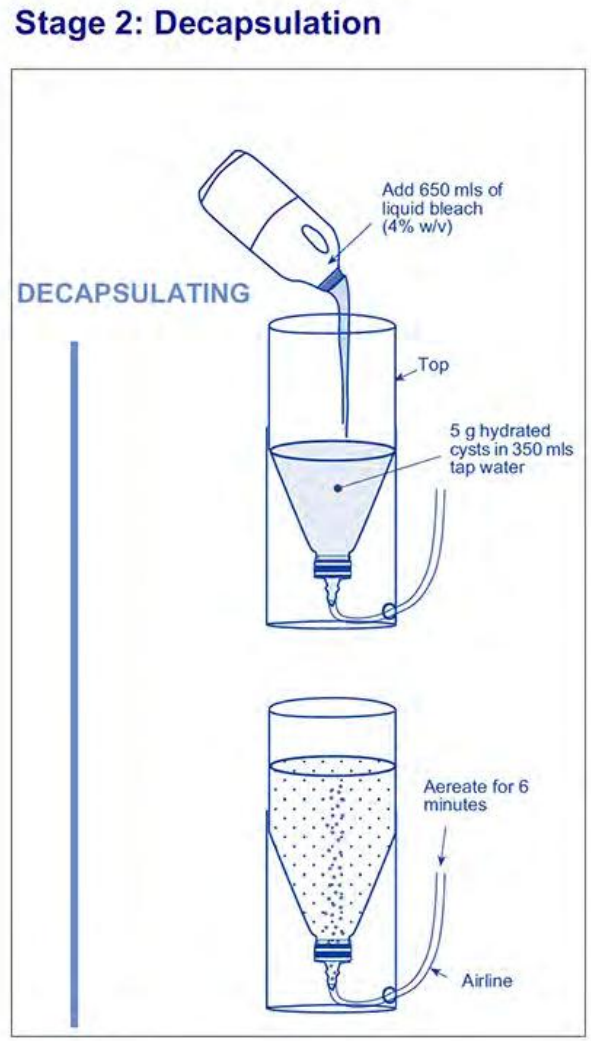
A brine shrimp decapsulating video is at:

https://www.youtube.com/watch?v=njmiRcJ7G3s

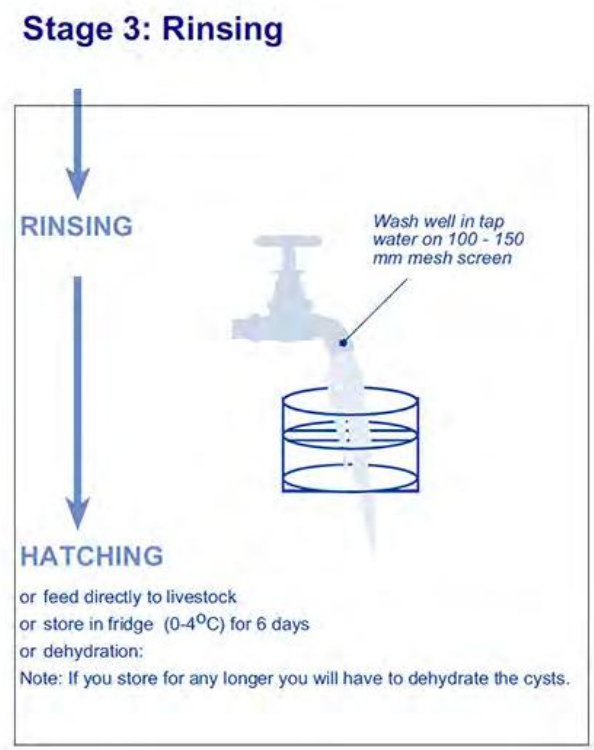
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Now many schools find de capsulation is not necessary.

However it is a variable that could form part of an experiment to test decapsulating as part of aquaculture for year 12 where you are feeding remnants of the chorion to fish as food.



Bob Moffatt



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Adult female brine shrimp ovulate approximately every 140 hours.

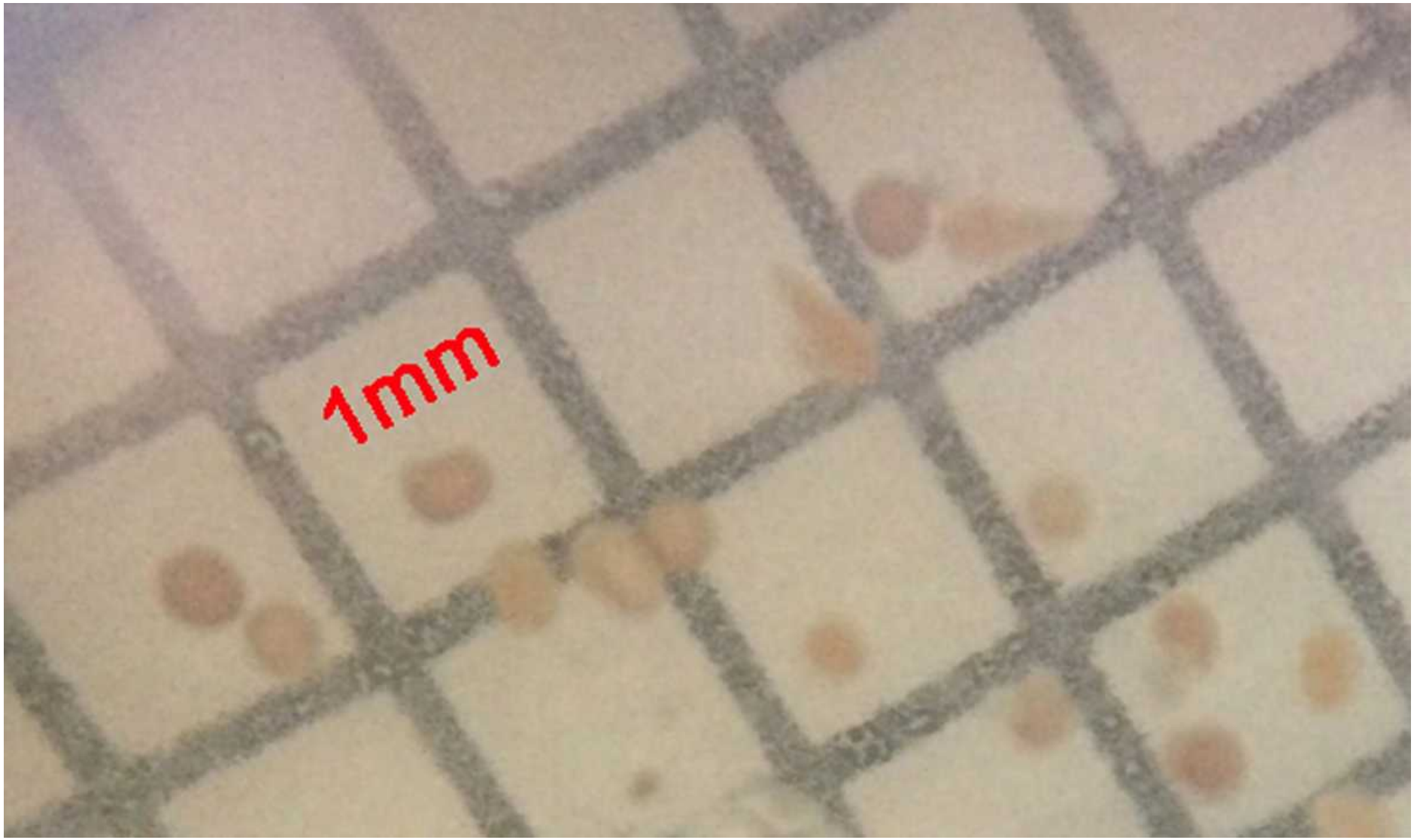


Artemia adult and egg

Photo Mick O'Connor

© Wet Paper Publications

Eggs are less than 0.1mm in size.



© Wet Paper Publications

Once placed in briny (salt) water, the eggs hatch within a few hours.

The nauplius larvae are less than 0.4 mm in length when they first hatch.

Brine shrimp have a biological life cycle of one year.



Artemia Nauplius

Photo Mick O'Connor

© Wet Paper Publications

In their first larval stage as nauplii they hatch within a few hours.

They are a brownish orange colour and do not eat because their mouths and anus are not fully developed.

You can watch them hatch at:

https://www.youtube.com/watch?v=7ZppkGdO-kU

(Turn the music down)



Artemia Nauplii 1

Photo By Adrian J. Hunter (Own work) [CC BY-SA 4.0 (https://creativecommons.org/licenses/by-sa/4.0)], via Wikimedia Commons

© Wet Paper Publications

They grow well in favourable conditions with good food, oxygen levels, and the right salt concentration.

By the second larval stage, after 12 hours, they moult and filter feed on particles of different microalgae, bacteria, and detritus.



Artemia Nauplii 2

Photo By Adrian J. Hunter (Own work) [CC BY-SA 4.0 (https://creativecommons.org/licenses/by-sa/4.0)], via Wikimedia Commons

© Wet Paper Publications

They moult through 15 moulting cycles and they can reach full adulthood in three to six weeks.



Artemia adult

Photos Mick O'Connor

© Wet Paper Publications

Your experiment

Artemia's tolerance limits could include the following limiting factors:

Abiotic
Temperature
pH
Light availability
Dissolved oxygen
Salinity

Biotic
Population density
Food availability



© Wet Paper Publications

The syllabus assessment task is to

- assess data to identify an organism's tolerance limit

QCAA Assessment IA2

Credit QCAA syllabus

4.5.2 Summative internal assessment 2 (IA2): Student experiment (20%)

Description

This assessment requires students to research a question or hypothesis through collection, analysis and synthesis of primary data. A student experiment uses investigative practices to assess a range of cognitions in a particular context. Investigative practices include locating and using information beyond students' own knowledge and the data they have been given.

Research conventions must be adhered to. This assessment occurs over an extended and defined period of time. Students may use class time and their own time to develop a response.

Specifications

Description

In the student experiment, students modify (i.e. refine, extend or redirect) an experiment in order to address their own related hypothesis or question. It is sufficient that students use a practical performed in class or a simulation as the basis for their methodology and research question.

In order to complete the assessment task, students must:

- identify an experiment to modify*
- develop a research question to be investigated*
- research relevant background scientific information to inform the modification of the research question and methodology
- conduct a risk assessment and account for risks in the methodology*
- conduct the experiment*
- collect sufficient and relevant qualitative data and/or quantitative data to address the research question*
- process and present the data appropriately
- analyse the evidence to identify trends, patterns or relationships

© Wet Paper Publications

Research claims have shown that:

Adults growing and cyst hatching should be done at optimal temperatures of 25-30^{0}C.



Abiotic

© Wet Paper Publications

Research claim

The preferable salinity is 30-35 ppt but they can live in fresh water for about five hours before dying.

Abiotic



© Wet Paper Publications

Research claim

A pH of more than five and less than ten is also suitable for the Artemia to ensure no fatalities but preferably 8.

Abiotic



Ecotesta

© Wet Paper Publications

Research claim

Fixed amounts of light are needed for hatching.

Abiotic



Artemia hatchery with light

Internet source lost – possibly a screen shot from a U tube video (happy to put in if can find source)

© Wet Paper Publications

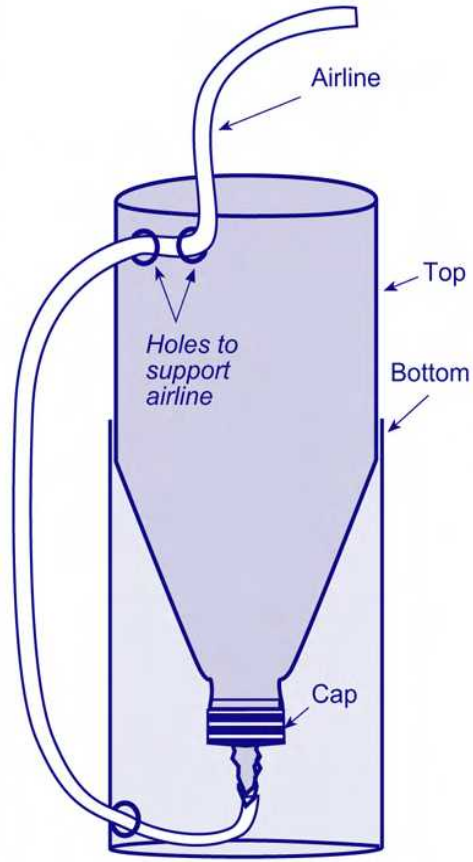
Research claim

Abiotic

Oxygen levels in the water dictate what the brine shrimp will eat if they are heavily feeding on microalgae they will look green in color.

Oxygen levels should be above 2 mg/L have been stated.







Hatchery aeration

Photos Bob Moffatt

© Wet Paper Publications

Research claim

Density of the cysts should be less than 5 grams (one and a half level teaspoons) of decapsulated hydrated cysts per litre.



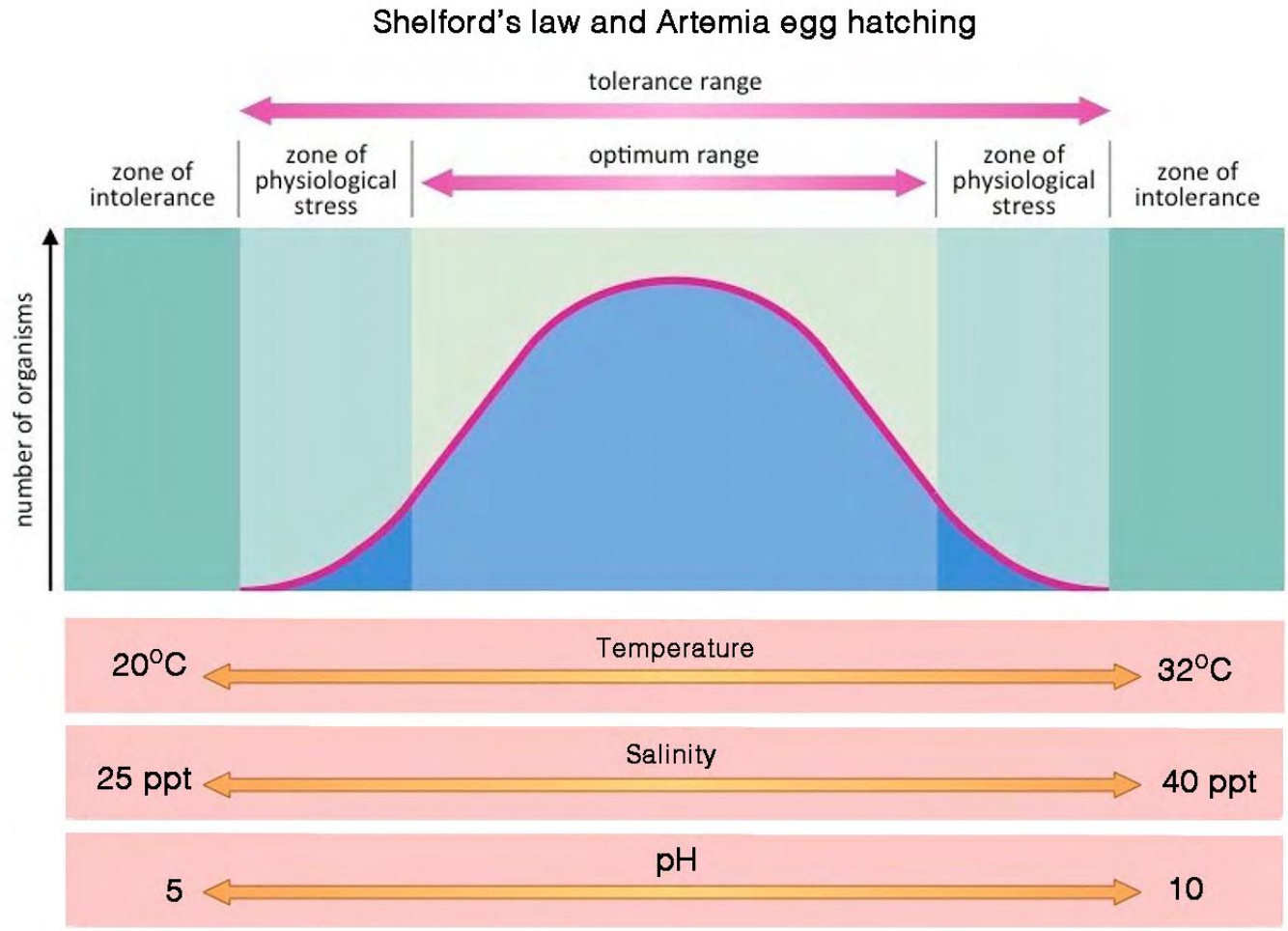
Wet Paper

Biotic – population density

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Shelford's law

can also be applied to the experimental design.



Shelford's law and Artemia

Illustration Bob Moffatt

© Wet Paper Publications

So lets look at what you need to do.

4.5.2 Summative internal assessment 2 (IA2): Student experiment (20%)

Description

This assessment requires students to research a question or hypothesis through collection, analysis and synthesis of primary data. A student experiment uses investigative practices to assess a range of cognitions in a particular context. Investigative practices include locating and using information beyond students' own knowledge and the data they have been given.

Research conventions must be adhered to. This assessment occurs over an extended and defined period of time. Students may use class time and their own time to develop a response.

Specifications

Description

In the student experiment, students modify (i.e. refine, extend or redirect) an experiment in order to address their own related hypothesis or question. It is sufficient that students use a practical performed in class or a simulation as the basis for their methodology and research question.

In order to complete the assessment task, students must:

1. identify an experiment to modify*
2. develop a research question to be investigated*
3. research relevant background scientific information to inform the modification of the research question and methodology
4. conduct a risk assessment and account for risks in the methodology*
5. conduct the experiment*
6. collect sufficient and relevant qualitative data and/or quantitative data to address the research question*
7. process and present the data appropriately
8. analyse the evidence to identify trends, patterns or relationships

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Identify an experiment to modify

The sample is

Assessment of temperature data to determine tolerance limits for egg hatching success in Artemia salina

Yours could be

Carbon dioxide (pH) (Ocean acidification)

Salinity (sediment runoff from the land)

Ethyl alcohol (a pollutant)

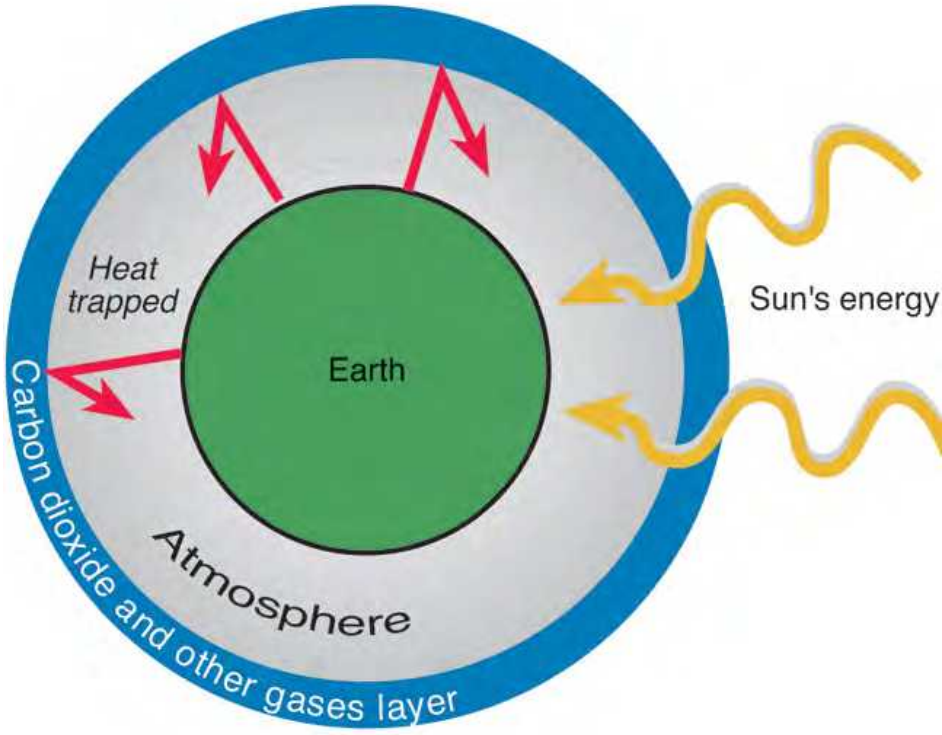
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Develop a research question to be investigated

Will global warming affect the hatching success of a Artemia salina?

Specifically,

Will the rate of hatching of brine shrimp eggs increase as temperature increases until an optimum temperature is attained?

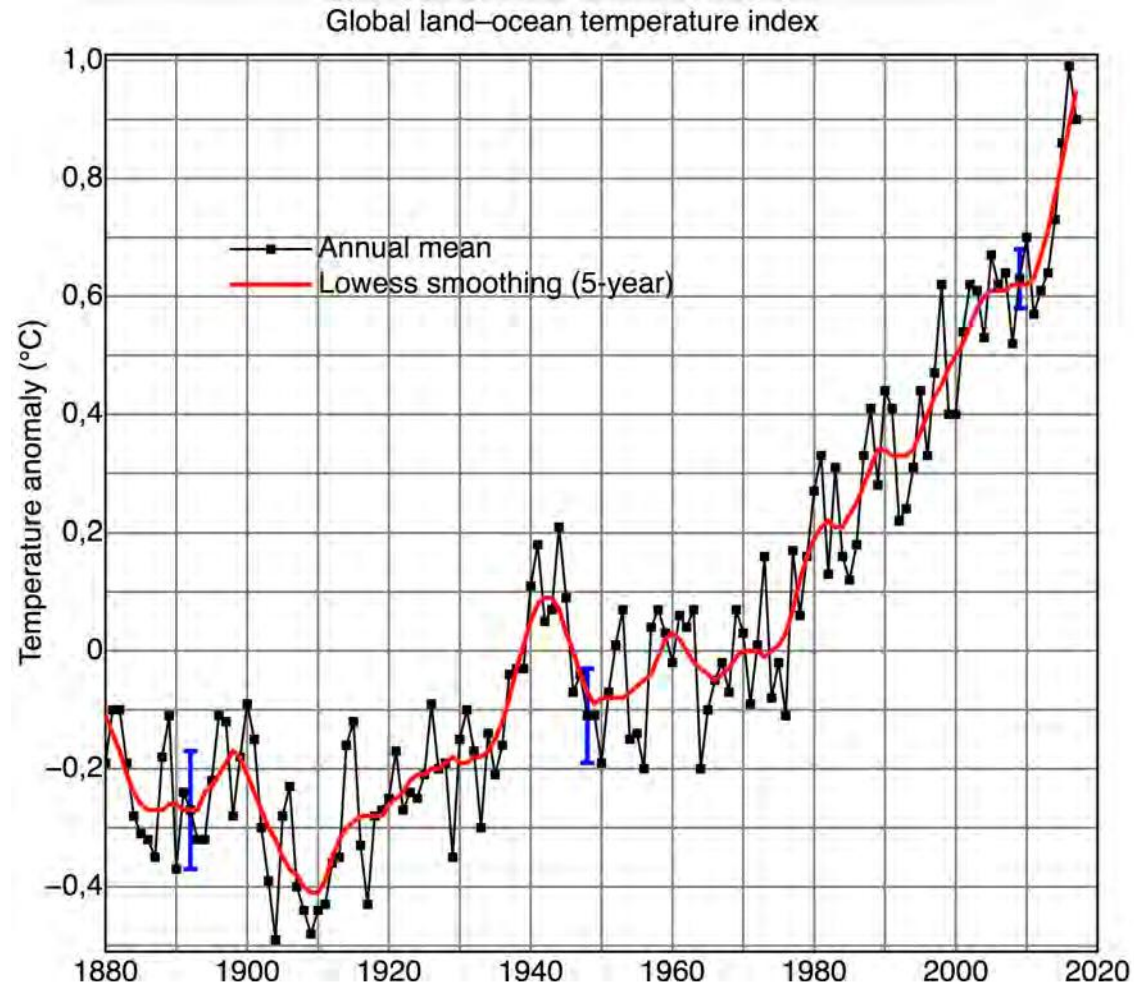


Trent Moffatt

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Research relevant background information to inform the modification

World wide water temperatures have been increasing rapidly since 1880.



Global temperature anomaly

By NASA Goddard Institute for Space Studies (http://data.giss.nasa.gov/gistemp/graphs/) [Public domain], via Wikimedia Commons

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This global warming of waters could affect the rate of hatching of brine shrimp eggs creating a worldwide shortage of Aquaculture food.



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This research article describes the effect of temperature on a related species of Artemia

Measurement of temperature and salinity effects on oxygen consumption of Artemia franciscana K., measured using fibre-optic oxygen microsensors

Article (PDF Available) *in* Hydrobiologia 575(1):109-115 · November 2007 *with* 643 Reads
DOI: 10.1007/s10750-006-0358-y

Cite this publication

Abstract

Oxygen consumption rates of nauplii of the brine shrimp Artemia franciscana Kellogg 1906 were determined over a range of salinities from 10 to 110ppm, in temperatures from 0 to 30°C, using a multi-factorial design. The oxygen micro-sensors employed have a fast response time and are capable of accurately measuring oxygen concentrations at temperatures well below 0°C. Oxygen uptake rate ranged from 0.03 to 0.66µmol O2mg−1h−1 and was sensitive to changes in both salinity and temperature. Temperature was the dominant factor affecting oxygen consumption rates, which showed a significant increase with increasing temperature. A slight decrease was measured in oxygen consumption with increasing salinity related to differential solubility of oxygen in waters of different salinities. Thermal sensitivity of oxygen consumption determined from calculations of Q 10, indicated physiological adaptation of Artemia nauplii to the ranges of temperatures tested.

Research article 1

https://www.researchgate.net/publication/225993308_Measurement_of_temperature_and_salinity_effects_on_oxygen_consumption_of_Artemia_franciscana_K_measured_using_fibre-optic_oxygen_microsensors

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This research article discusses -

Impacts of Climate Change on Marine Organisms and Ecosystems

https://www.sciencedirect.com/science/article/pii/S0960982209011816



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Current Biology

Volume 19, Issue 14, 28 July 2009, Pages R602-R614

CellPress

Review

Impacts of Climate Change on Marine Organisms and Ecosystems

Andrew S. Brierley [1], Michael J. Kingsford [2]

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https://doi.org/10.1016/j.cub.2009.05.046

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Human activities are releasing gigatonnes of carbon to the Earth's at- ...genes to ecosystems, over Direct consequences of cumulative post-industrial emi... ...g ecosystem services and threatening temperature, perturbed regional weather ... physical change are unprecedented in some cases. changed nutrient loads and ... ...ikely to be commensurately quick, although the resistance and consequences ... ...se of organisms and ecosystems is highly variable. Biological changes founded in physiological response manifest as species range-changes, invasions and extinctions, and ecosystem regime shifts. Given the essential roles that oceans play in planetary function and provision of human sustenance, the grand challenge is to intervene before more tipping points are passed and marine ecosystems follow less-buffered terrestrial systems further down a spiral of decline. Although ocean bioengineering may alleviate change, this is not without risk. The principal brake to climate change remains reduced CO_2 emissions that marine scientists and custodians of the marine environment can lobby for and contribute to. This review describes present-day climate change, setting it in context with historical change, considers consequences of climate change for marine biological processes now and in to the future, and discusses contributions that marine systems could play in mitigating the impacts of global climate change.

Main Text

Introduction

When Earth formed about 4.5 billion years ago there were no oceans. Since then, as surface water has accumulated, the filling ocean basins have been the reaction chamber for the

Research article 2

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The experiment you are modifying is

Raising Artemia as food source for aquaculture organisms

By

O'Connor M., and Hourigan L., *Aquaculture for Senior Students*, Wet Paper Publicaitons, 2014 pp's 96 – 101.



Photo Bob Moffatt

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Risk assessment and account for risks in the methodology

Safety precaution, animal ethics and risk assessments.

Lab coats, foot and skin protection.

Follow school safety precautions for glassware and salt water solutions –

Methodology

-(sodium hypochlorite MSD)
-modify school risk assessments for laboratory and incubators and water baths (if applicable)





Risk assessment
Photo Mick O'Connor

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Conduct the experiment

Hypothesis

As the temperature increases, the rate of hatching success of brine shrimps also increases until optimum temperature is achieved.

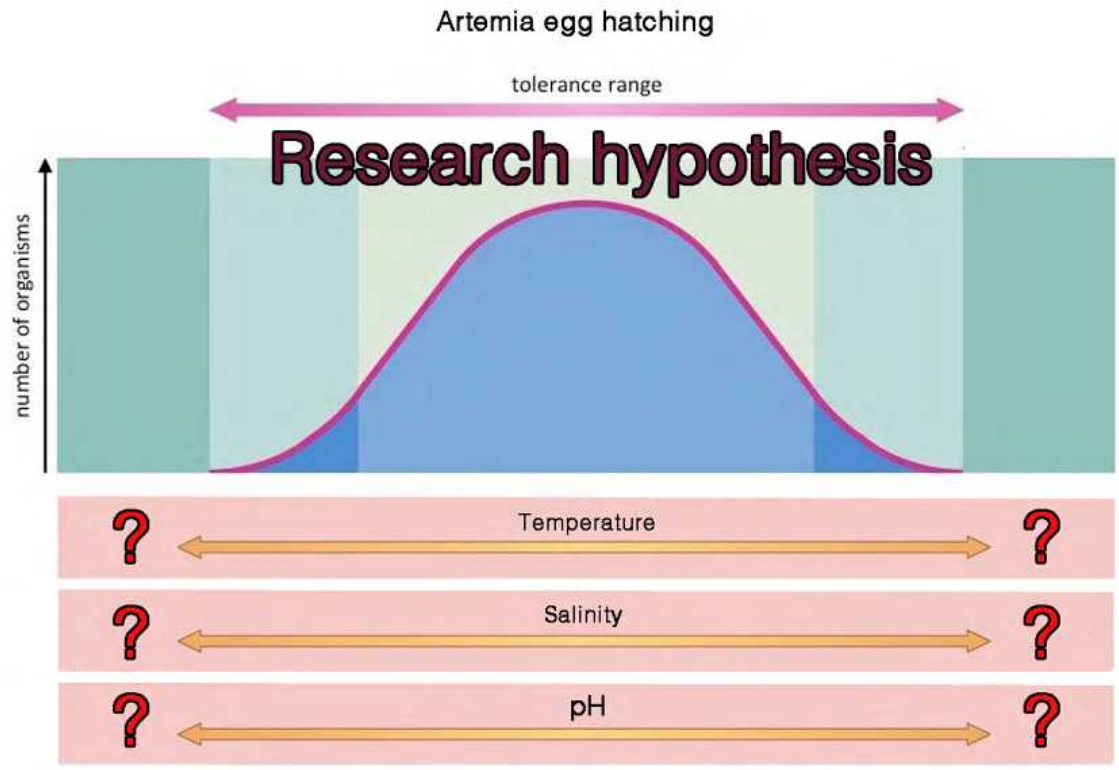


Illustration Bob Moffatt

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Variables involved

Your school may have a different way of doing this

Types of variables	Ways variables can be controlled
Manipulated variable Temperature (°C)	Different use of temperatures 22°C, 29°C and 32°C to incubate brine shrimp egg cysts
Responding variable Number of shrimps hatched	Calculated by catching using fine glass pipette and counting the number of larva that swim towards a light source for 2 days
Fixed variables Salinity Light pH of water Water volume	 Use same weight of salt (7g) for each fixed volume of water (200 mLs) Place in same light Ph of water to be kept between 8 – 8.5 Use same volume of water (petri dish – to be verified)

Illustration Bob Moffatt

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Apparatus

Artemia hatchery

See also

http://www.solidgoldfish.com/2013/11/easy-diy-brine-shrimp-hatchery.html



Photo Mick O'Connor

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Materials - eggs

Buy decapsulated 10 gram eggs from local supplier

Eg: http://theaquariumshop.com.au

Cost about
$20

Light

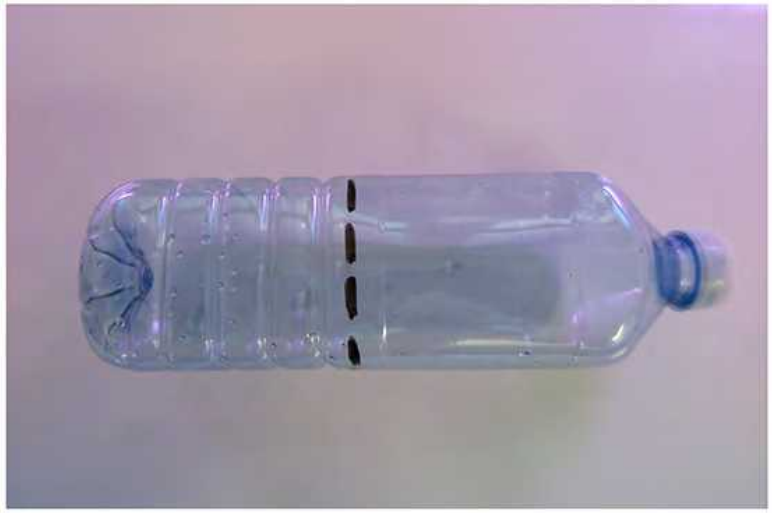
Thermometer



Artemia eggs
Photo internet unknown

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Materials – hatchery make this at home









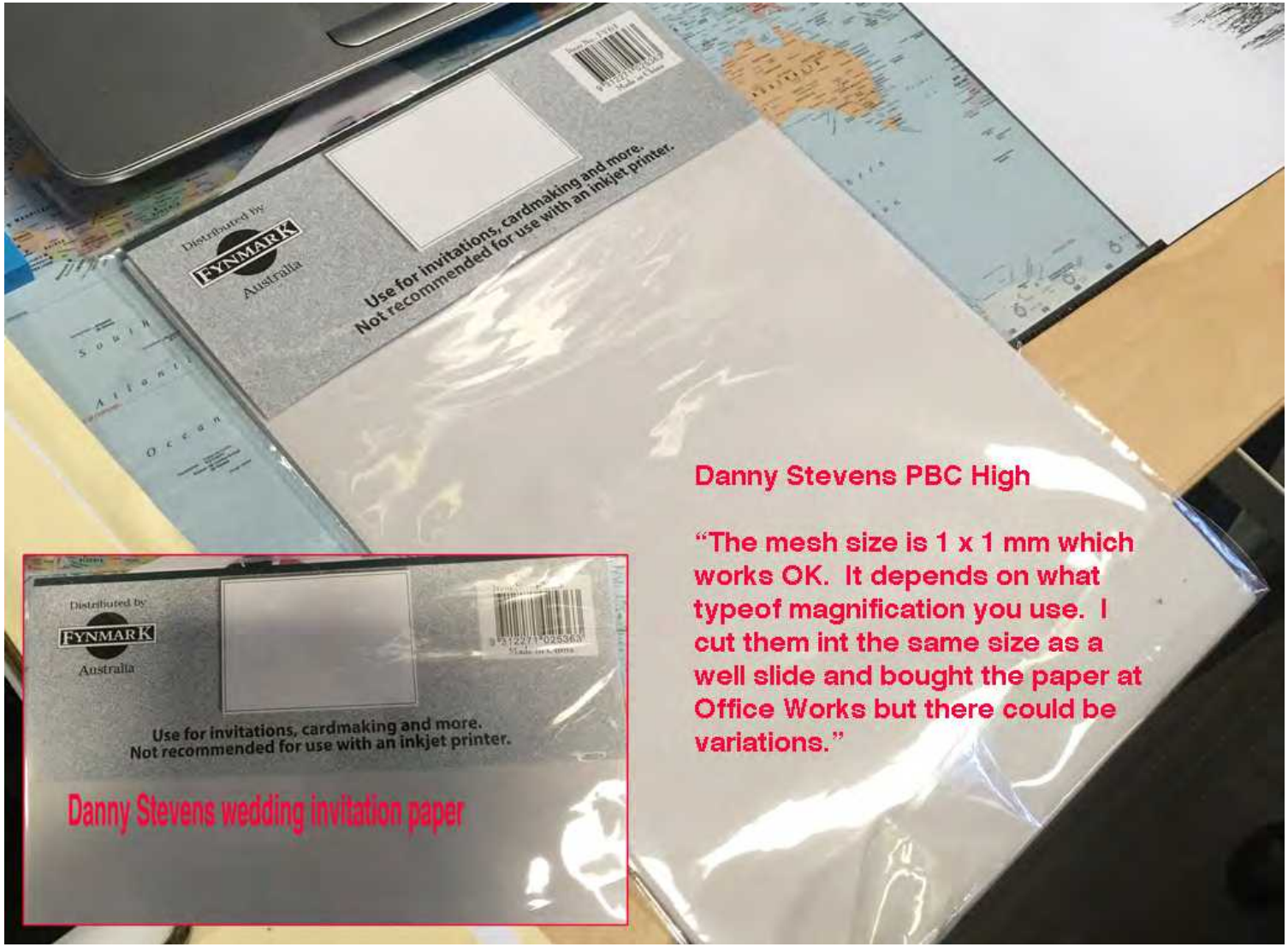






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Materials – egg counting slide



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Cut out graph paper squares

Put on photocopier

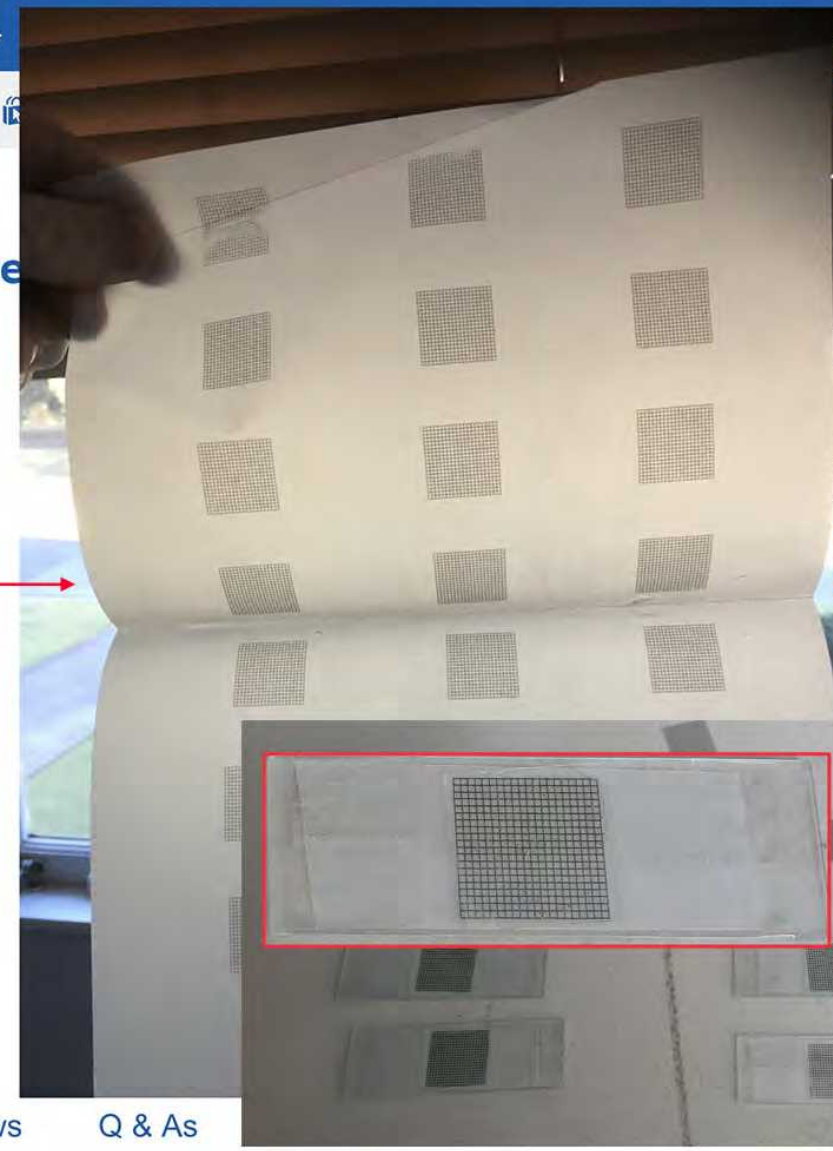
Run this paper through the photocopier

Take the clear sheet

Use it as a well mount to make a microscope slide



CLEARANCE

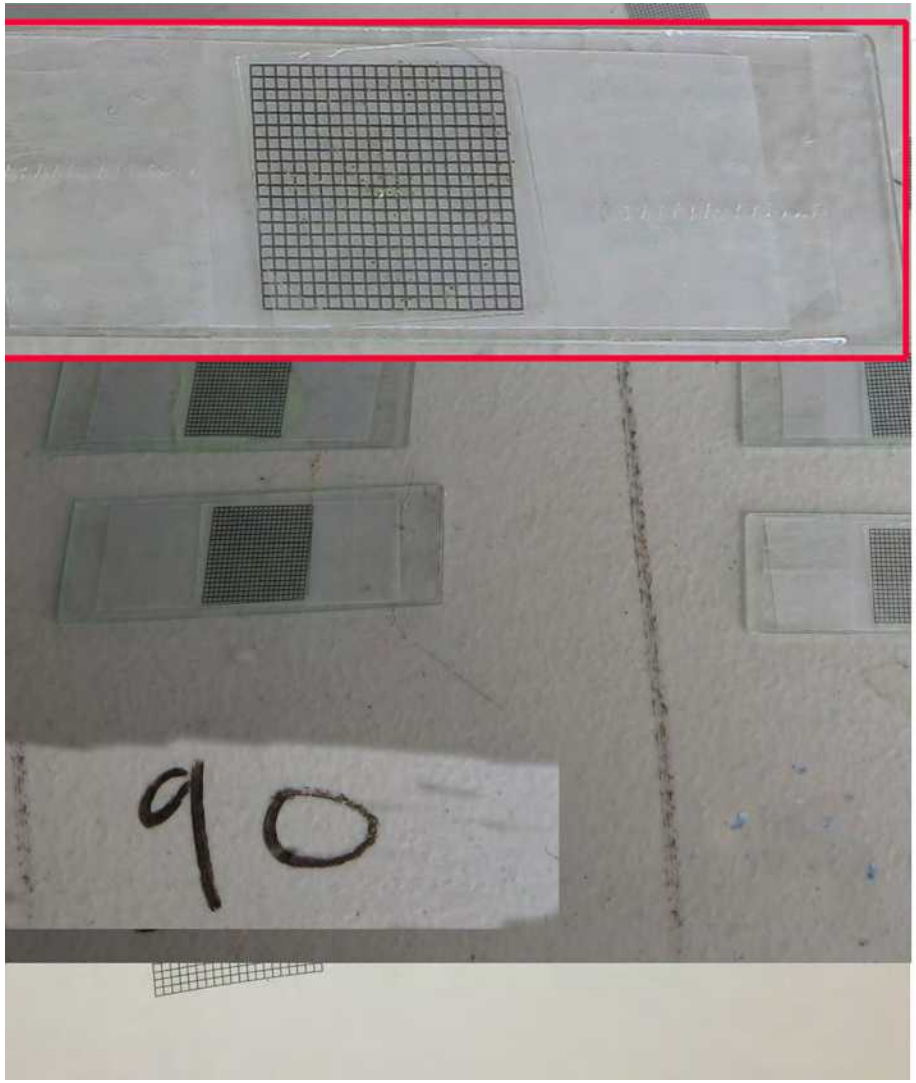


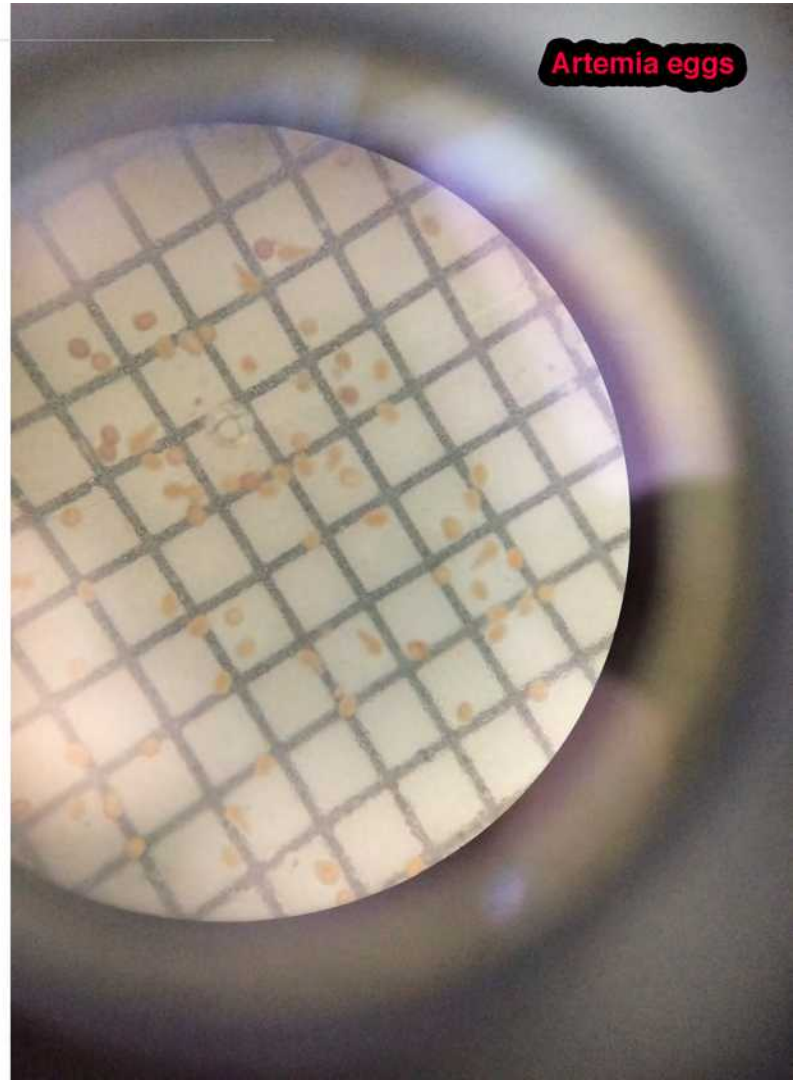
Thanks Danny Stevens

Features Specifications Customer reviews Q & As

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Microscope slides are now used to count the hatched eggs



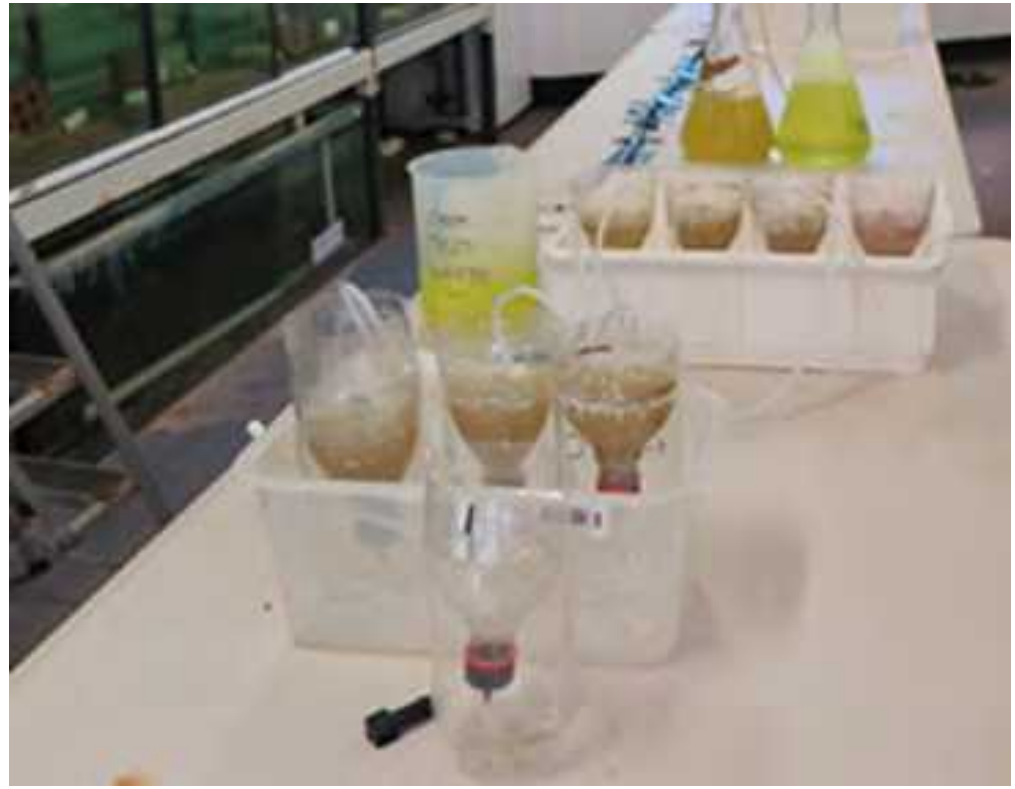


Danny Stevens

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Collect sufficient and relevant qualitative and quantative data to address the research question

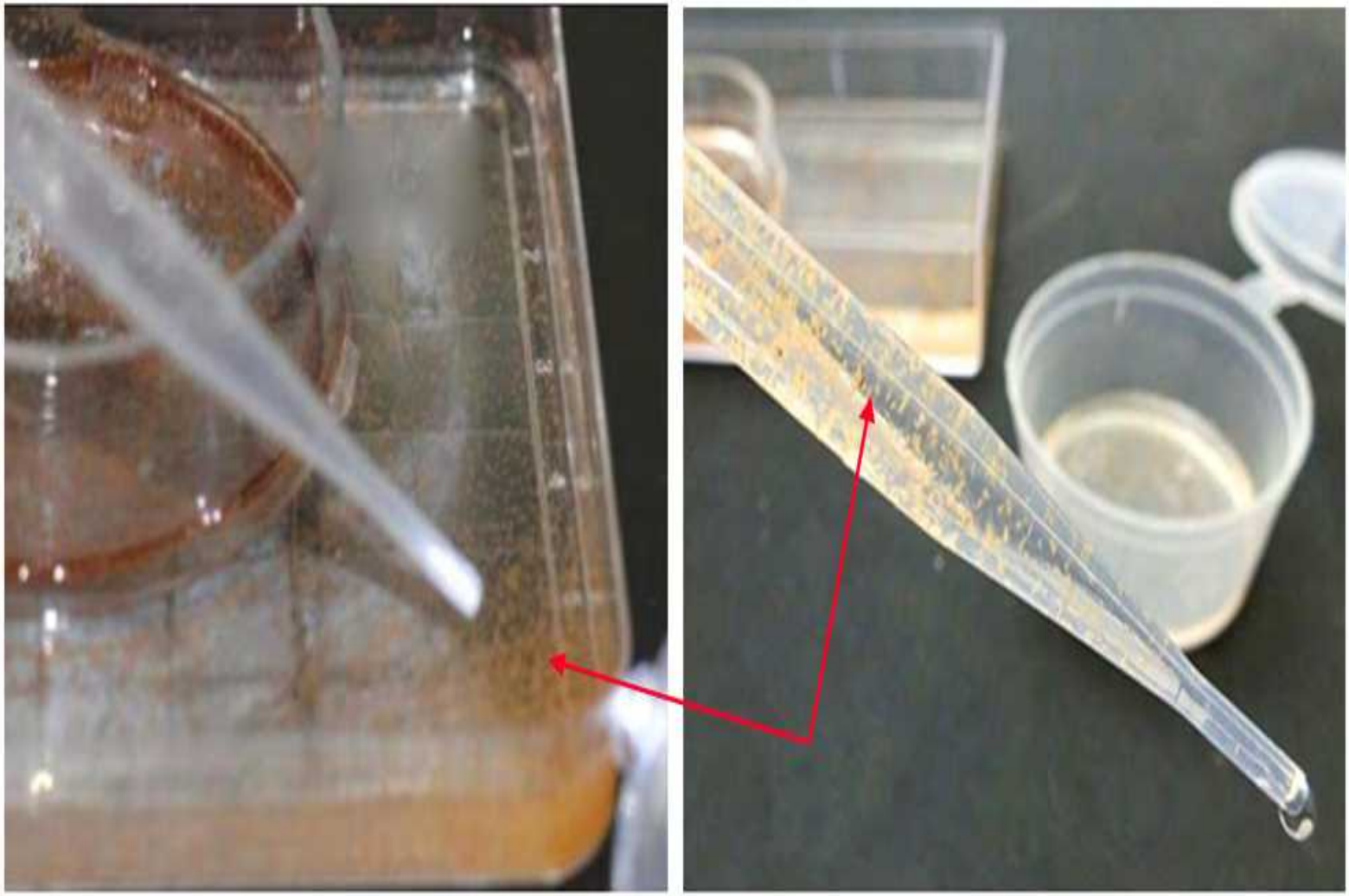
- In this sample experiment, no decapsulation was used.
- Three experimental hatcheries were filled with a known salinity – 35 g/Litre and incubated for 24 hours.



Bob Moffatt and Danny Stevens

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A fixed volume of Artemia nauplii were then collected in a pipette and placed on the 1mm graph paper well mount.



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Eggs were counted and photographs taken using a mobile phone.



Danny Stevens

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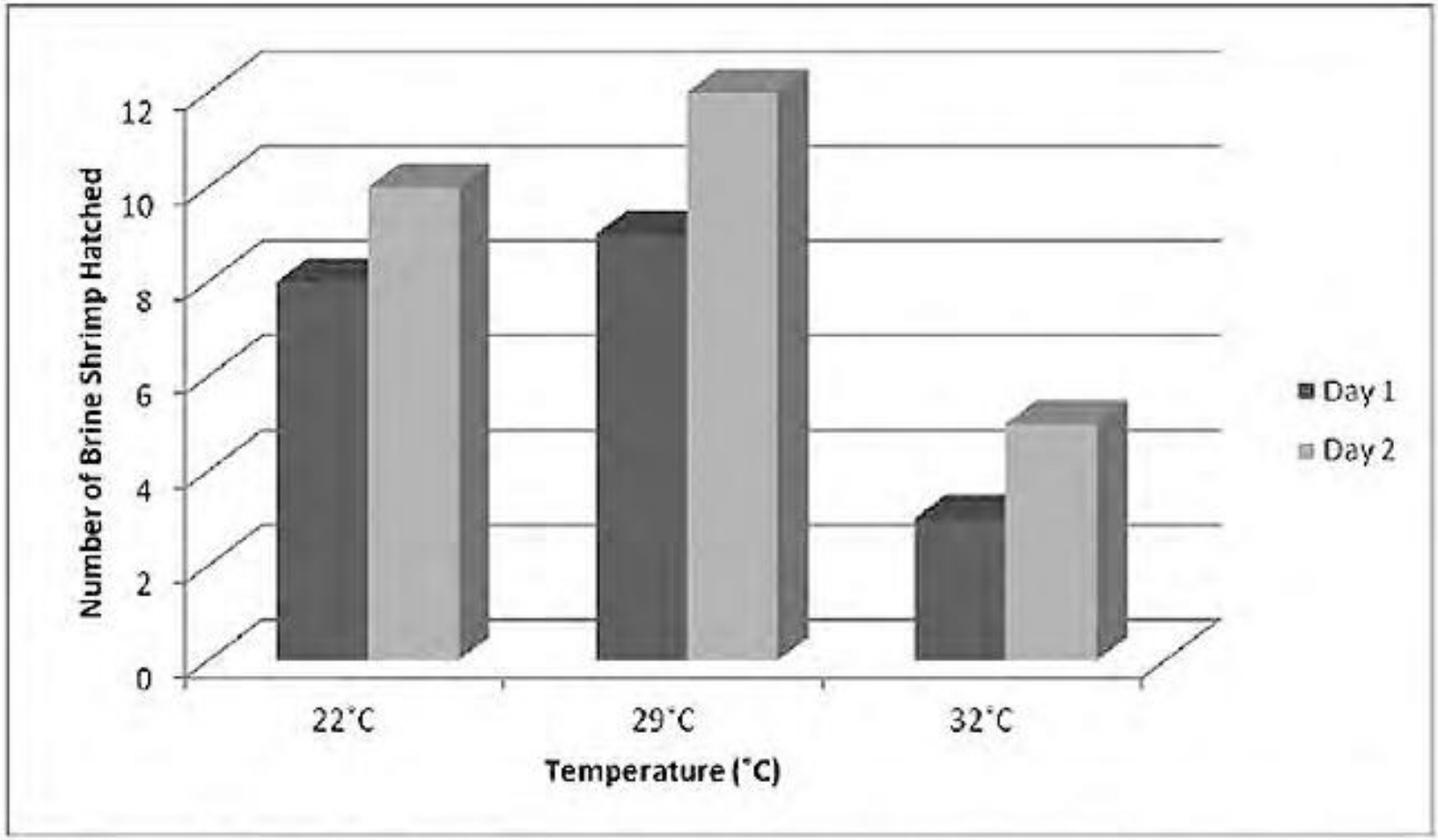
Results were tabulated over two days

Temperature (°C)	First Day (After 24 hours)	Second Day (After 48 hours)
22	8	10
29	9	12
32	3	5

Table 2: Number of Brine Shrimps hatched in respective temperature by day count

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Artemia temperature experiment result graph



Graph 1: Number of Brine Shrimp Hatched in respective temperature by day count

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Process and present the data appropriately

Table 1 shows the number of brine shrimps with respect to temperature 22^0C, 29^0C and 32^0C) and day count.

To analyse the data we look at the temperature at which the brine shrimps hatched.

Temperature (°C)	First Day (After 24 hours)	Second Day (After 48 hours)
22	8	10
29	9	12
32	3	5

Table 2: Number of Brine Shrimps hatched in respective temperature by day count

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Temperature (°C)	First Day (After 24 hours)	Second Day (After 48 hours)
22	8	10
29	9	12
32	3	5

Table 2: Number of Brine Shrimps hatched in respective temperature by day count

22^0C

On the first day at 22^0C, 8 larvae were counted or about 40% of the total brine shrimp eggs used in the experiment.

On the second day 10 larvae were counted the light meaning 50% had hatched.

29^0C

On the first day at 29^0C, 9 or (45%) of larvae had hatched which increased to 12 or 60% on the second day.

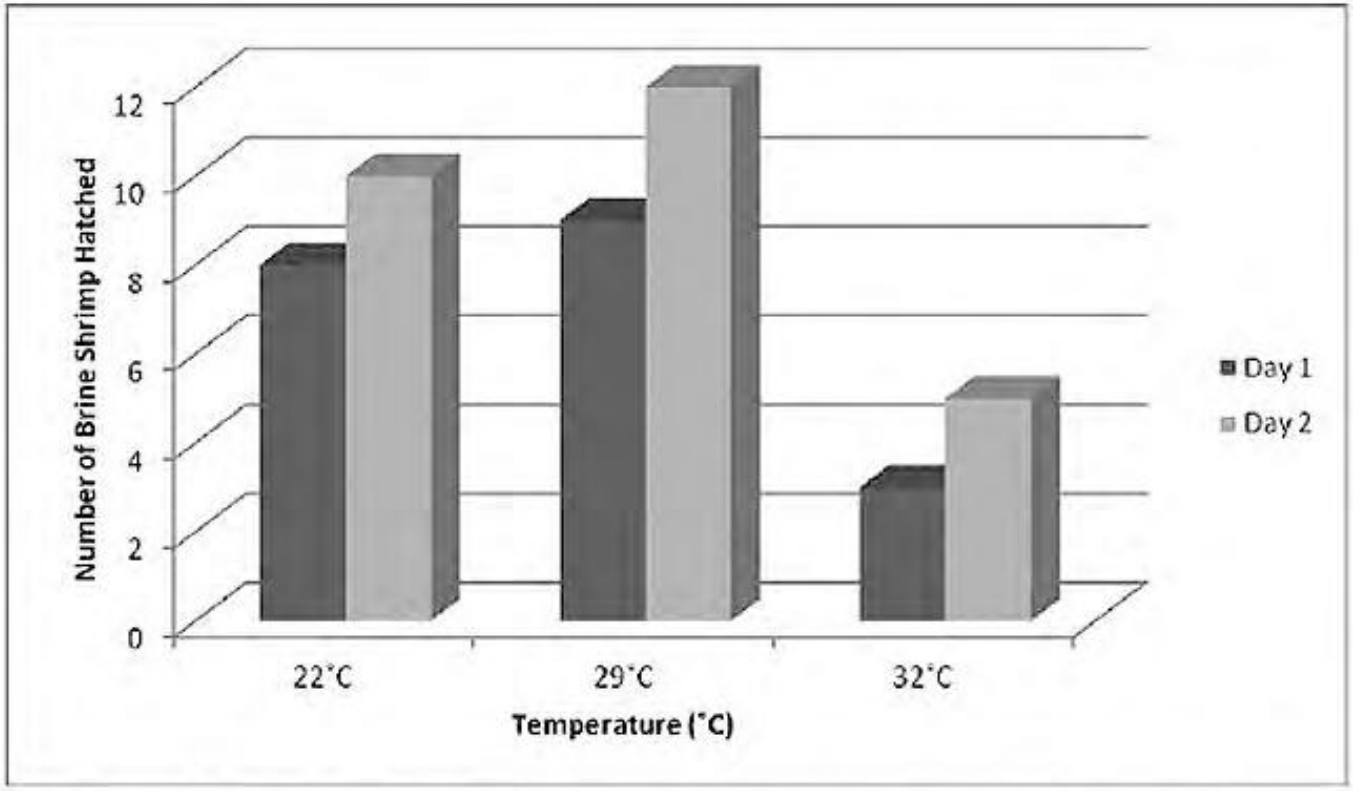
This was the highest percentage hatching for the experiment.

32^0C

On the first day at 32^0C only 3 had hatched (or 15%) and by the second day only increased to 5 or (25%) of the total amount of Artemia eggs used.

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So it can be concluded that the highest number of brine shrimp hatch at 29^{o}C and the lowest at 32^{o}C.



Graph 1: Number of Brine Shrimp Hatched in respective temperature by day count

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Analyse the evidence to identify trends, patterns or relationships

The optimum temperature for hatching is 29^{o}C.

Beyond this temperature the enzyme reaction decreases and is predicted to completely stop at about 40^{0}C.

Here the enzyme is completely denatured.

So it can be said that at 32^{o}C the hatching enzyme already starts to denature causing the hatching rate to drop significantly.



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Abstract

Our earth is experiencing global warming which already reach an alert stage and this will, for sure, have a profound adverse effects on various form of live, either land or marine life. To develop an understanding on how temperature effect the rate of growth and survival of marine life, an experiment was designed to determine the optimum temperature needed by brine shrimp to hatch and survive. This experiment accomplished by using salt water with 0.2% salinity in three respective test tubes which was then placed in three different temperature range (22°C, 29°C and 32°C) with about 20 egg cysts of brine shrimp. The number of hatched larvae in each test tube was counted on the next day and the following day using light and was recorded.

Introduction

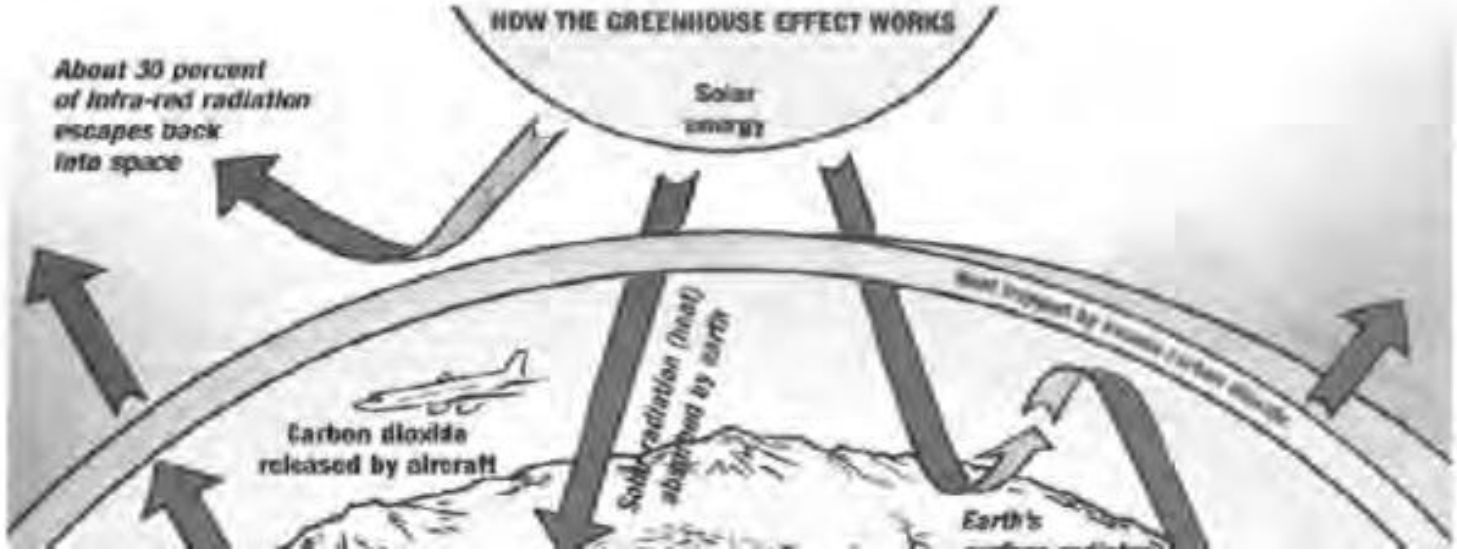
Abstract sample

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1. Global Warming(Greenhouse Effect)

Greenhouse effect is a phenomenon in which earth's atmosphere traps the heat from the sun and prevents it from escaping. Atmosphere acts like a greenhouse glass in which sunlight enters through transparent glass but then, the heat released by plants (infrared radiation form) is not allowed to escape. Thus the temperature increases inside the greenhouse. This is an analogy for what is happening to our earth but in this case, certain gases known as greenhouse gases act as atmosphere and this contributes to global warming.



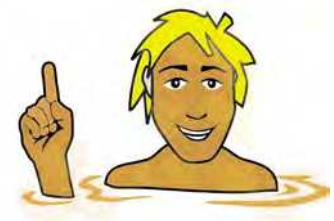
Introduction sample
From https://www.scribd.com/doc/149338069

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The rate of hatching of brine shrimp eggs increases as temperature increases, until an optimum temperature is attained.

This experiment shows the optimum temperature is between 22^{o}C and 29^{o}C.

So the hypothesis is accepted.



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Further investigation

Use different salinities to determine an optimum for hatching rate.

Temperature and pH are controlled this time using different amounts of salt 2, 4, 6 ,8 grams in 40 ml of water.



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T055 Apply zonation concepts



Bob Moffatt

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Syllabus statement

At the end of this topic you should be able to ...

Apply

the concept of zonation using the following terms: intertidal, pelagic (neritic, oceanic) and benthic.



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Apply

- use knowledge and understanding in response to a given situation or circumstance;

- carry out or use a procedure in a given or particular situation

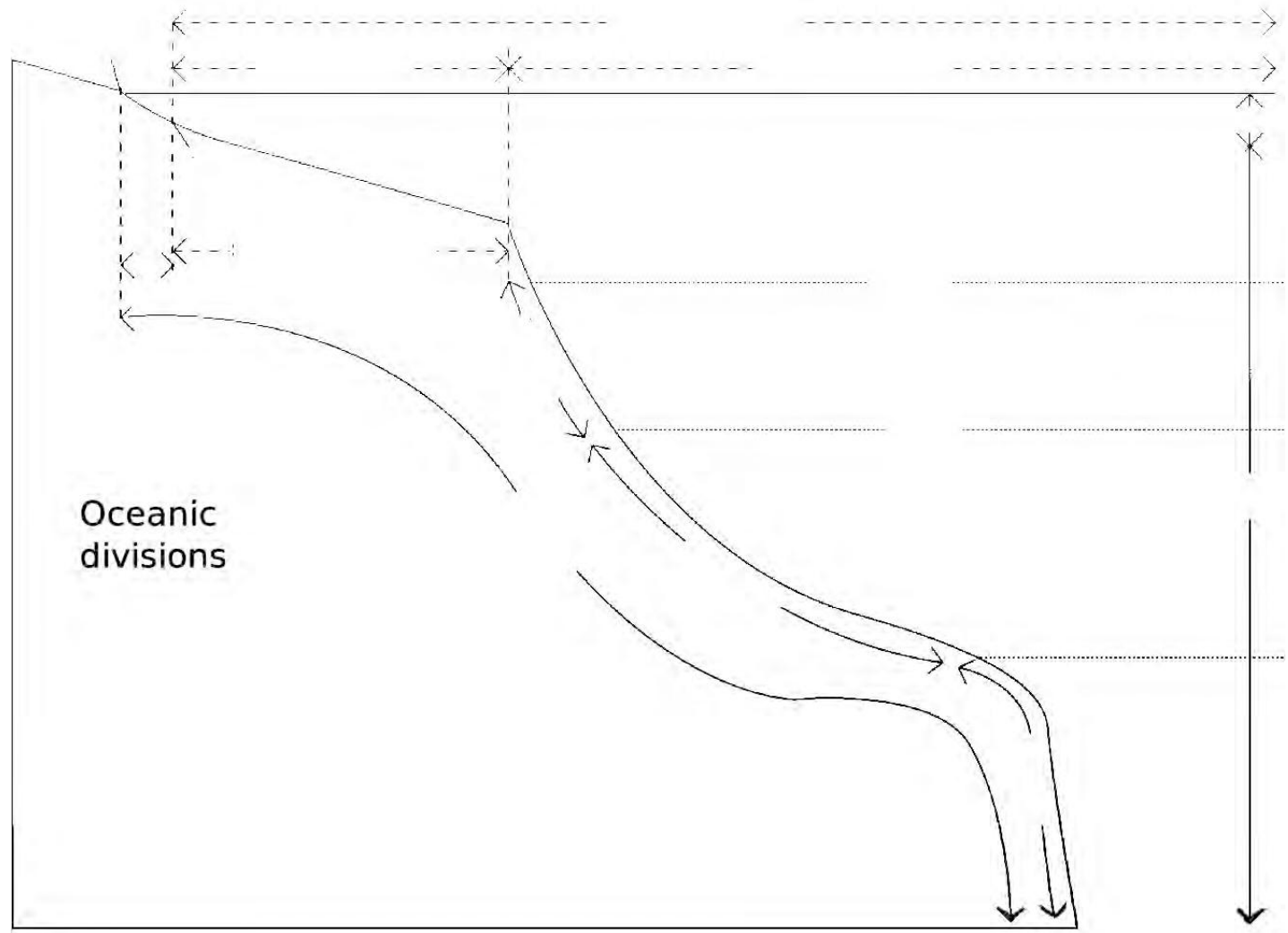




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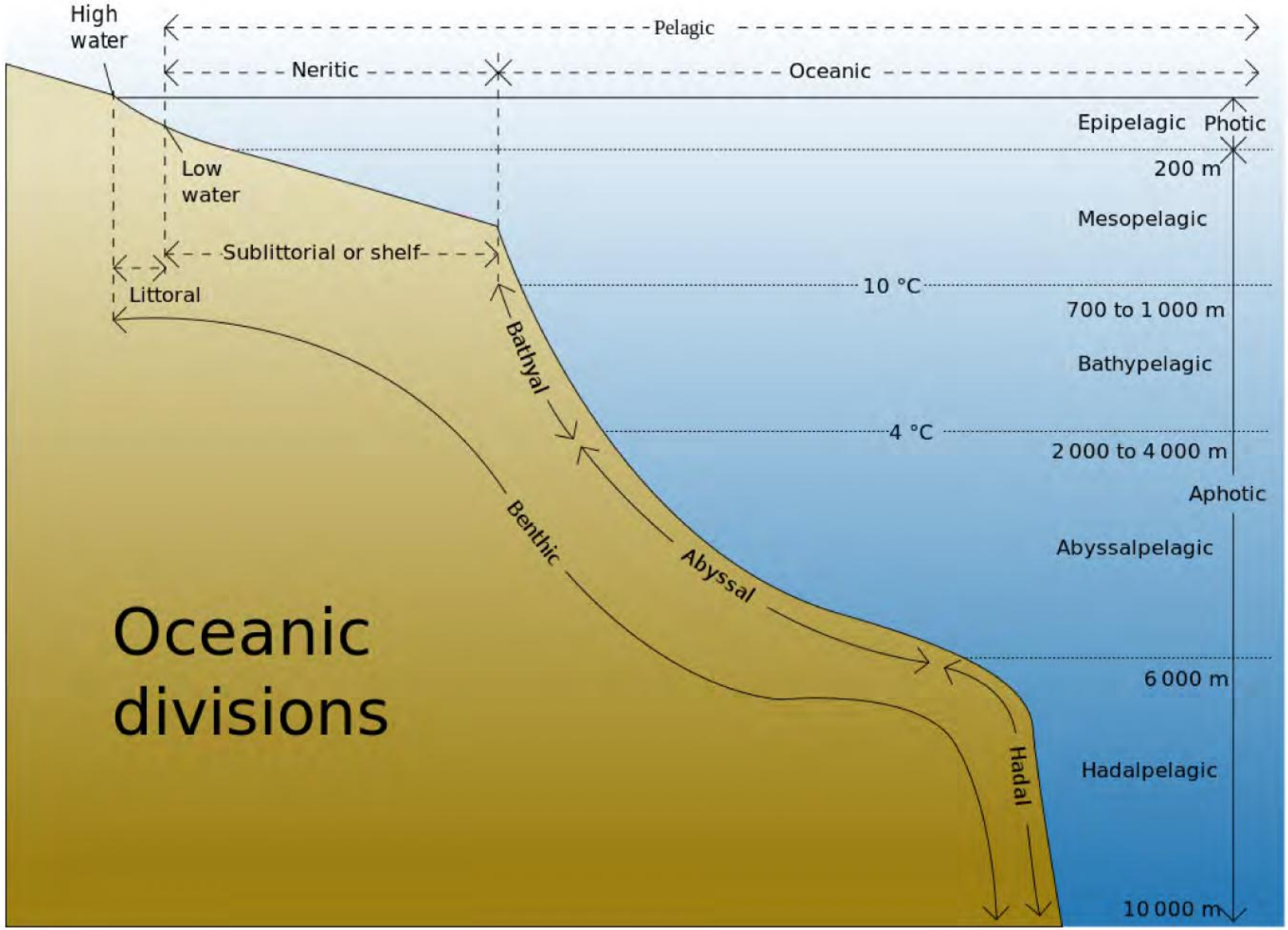
Question 1

Use the illustration that follows to complete the following diagram of oceanic divisions.



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Q2. Complete the following table to apply the concept of zonation to animals from the rocky shore.

Zone	Distance from shore	Abiotic factor	Application / effect	Example
Supra littoral zone				
Littoral zone				

Zone	Distance from shore	Abiotic factor	Application / effect	Example
Sublittoral zone				
	Application - Competition			

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Zone	Distance from shore	Abiotic factor	Application / effect	Example
Supra littoral zone	Close to shore. Exposed 14 days due to neep tides	Tides and storms also play a major factor in controlling these factors with	This means some animals and plants will only get water once every 14 days. High temperatures for long days means fewer places to hide from predators, high salinity and little food. Animals are typically small and have a high tolerance to desiccation (drying out)	Shells have special adaptions such as an operculum to keep water in. Lichens dominate on exposed rocks Salt hardy plants.
Littoral zone	Between high and low tide mark	Water, lower salinity, greater oxygen called the littoral zone. Water comes in on a daily basis with daily tides depending on the tidal range. The fact that there is more water with large variations in physical properties creates a zone for animals and plants who have a specific tolerance for these properties.	Animals and plants found in the littoral zone will be those who can withstand these changing factors. Boulders provide more places to hide from predator. Pools reduce temperatures, salinity levels and allow more oxygen to dissolve. There are more animals and plants so there is more food. However with the availability of water resulting from the tide, oxygen, salinity, nitrate and temperature levels will vary greatly.	Sea anemone will feed during high tide but then roll up into a ball at low tide and live deep in a crevice to prevent desiccation and being eaten by predators such a crabs. Crabs will be flattened so they can squeeze between rocks and can move to where water is and hang on as waves break over them. Decomposers live in bottom of rock pool can withstand temperature changes. Fish slow down metabolic rate to conserve oxygen. Algae have tough outer covering to prevent desiccation.

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Zone	Distance from shore	Abiotic factor	Application / effect	Example
Sublittoral zone	Below low water	Waves enhanced by cyclones and severe weather events determine what lives in this zone.	Waves enhanced by cyclones and severe weather events determine what lives in this zone. Animals and plants either need to be cemented onto the rocks or have strong suction mechanisms to hang on. Waves also determine the shape of organisms and the ways they feed themselves. Storm events can move sand causing populations of algae to populate exposed rocks. Longshore drift can cover barnacles causing death Oxygen levels are high because of the great turbulence caused by waves Competition can play a major role in some species	Barnacle cement themselves to rocks, disperse wave action by their shape and feed with special appendages as waves recede. Barnacles also have feeding Cirri which come out as waves retreat to catch plankton and then pull them back in Chitons and limpets have a strong muscular foot to hang on Long shore drift can move sand to cover barnacles which suffocate and die. Storms are needed to uncover barnacles to allow them to reproduce and new barnacles recolonise areas. The banding of differs types of algae on exposed rocks can be caused by storms exposing rocks by washing away sand Different oxygen levels can then lead to different bands on the newly colonised rocks and barnacles uncovered by storm event.
	Application - Competition In the last century, a Scientist Joseph Connell was interested if he could prove interspecific completion affected zonation on a rocky shore on two species of barnacles. The barnacles were a small one (Chthamalus) and a larger one (Balanus) and occupy two separate places on a rocky shore Experiment 1: Connell removed small barnacle from the upper area, and no big barnacles replaced it. Experiment 2: Connell removed big barnacles from the lower area and small barnacles replaced it. Conclusion The smaller barnacle's zonation is limited by interspecific competition.			

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Q3. Complete the table for marine life from the oceanic and benthic zones to apply zonation principles.

Zone	Distance from shore	Abiotic factor	Application / effect	Example
Pelagic				
Benthic zone				

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Zone	Distance from shore	Abiotic factor	Application / effect	Example
Pelagic	Neretic - the relatively shallow part of the ocean above the drop-off of the continental shelf, approximately 200 meters in depth. Oceanic zone the area of the ocean lying beyond the continental shelf where the water depths drop to below 200 meters in depth	Epipelagic zone as light can penetrate through the whole zone. Epipelagic (Photic) Mesopelagic (to 10oC), Bathypelagic (To 4 oC) Abyssal pelagic to 4000 metres Hadalpelagic below 4000 metre Temperature Temperature decreases rapidly from the epipelagic zone to much colder deep water mesopelagic zone	The neretic and oceanic epipelagic have light, constant temperature and containing the greatest number of larger animals.	As a result of this, the epipelagic zone is also where most pelagic animals are found, and they are often big. Tunas, sharks and large marine mammals such as whales and dolphins travel in these waters. We also find planktonic jellyfish and comb jellies. And tides do not occur in these zones and the influence of waves is limited to the top .1%, banding as seen on a rocky shore is not obvious. The vertical migration of plankton could be considered as a band of organisms that move from place to place. Every day, zooplankton make their way to deep water in the morning and rise as the sun sets. This process, known as diel vertical migration, is carried out all over the world by marine and freshwater plankton alike .
Benthic zone	From shore to deep ocean	Massive range from intertidal to abyssal	Benthic organisms can be found in ALL zones of the sea. .	Intertidal benthos Animals dig, burrow or attach to others. Plants have holdfasts to hang on.

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Definition

Zonation refers to the patterns that are observed in a community over a distance, based on the distinct fauna and flora found along the area.

Although the different zones are characterized by the dominant species inhabiting them, the separation of zones isn't always a clear straight line, but instead there is some overlapping of species, particularly where the zones meet.

Sometimes, however, the overlapping can disappear or be very small if one species completely out-competes the others by predation or competition over resources, and we can see clear-cut zonation.

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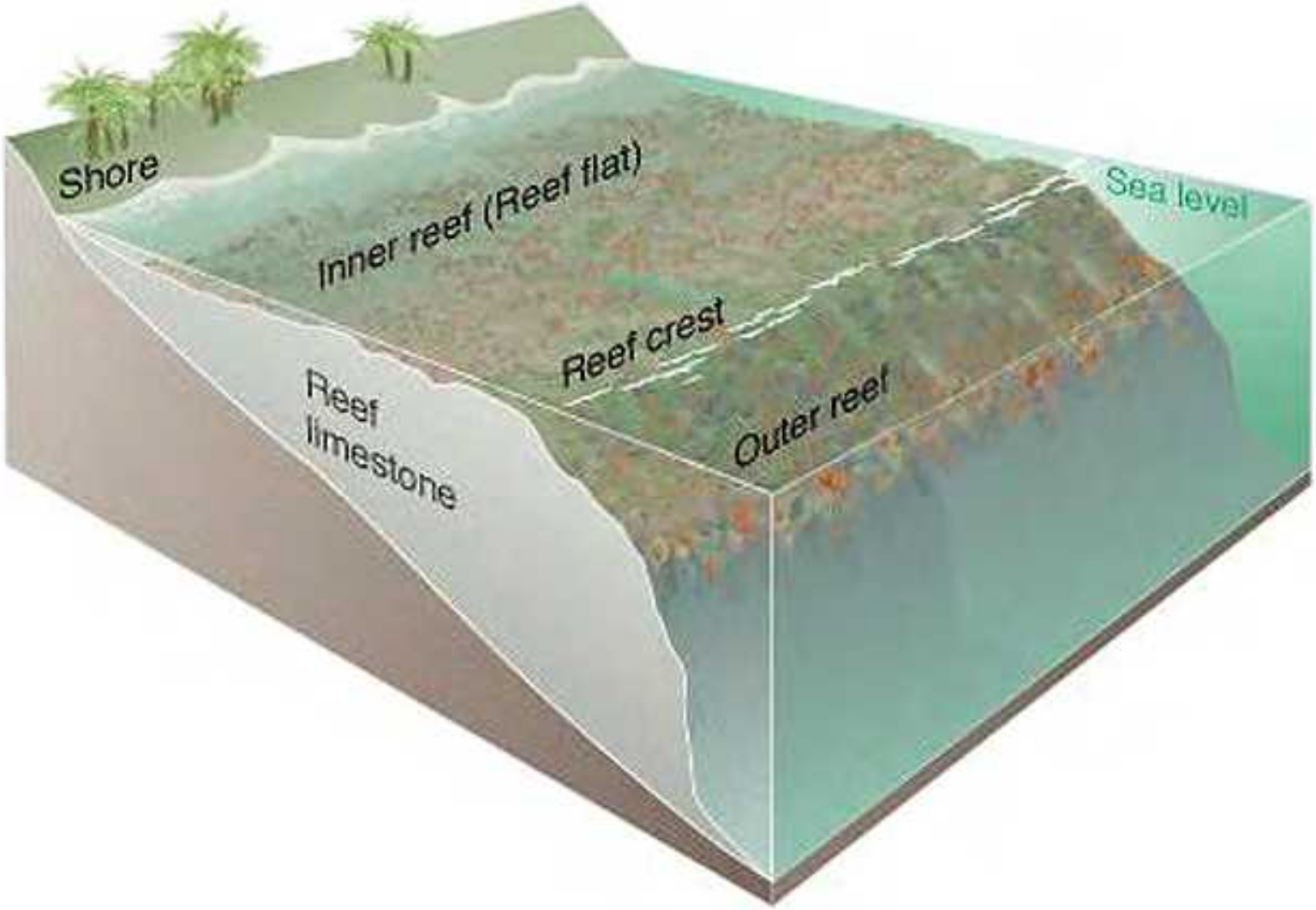
So, on a reef from the air, you can see groupings of animals and plants.



Reef zones

Photos Bob Moffatt

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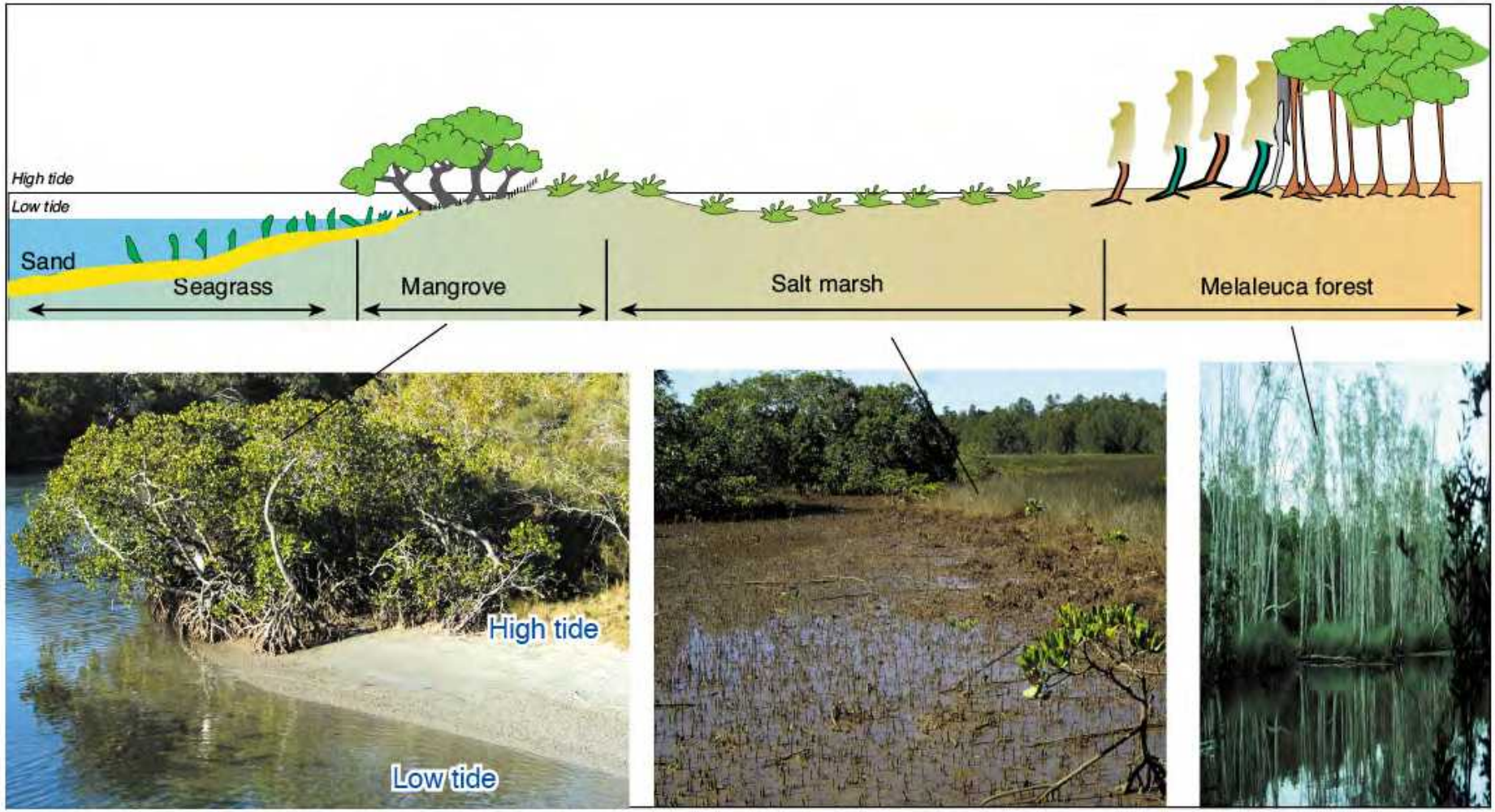


Reef zones

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In mangroves, you can see similar groupings as you progress from the tide mark.



Mangrove zones Photos and illustration Bob Moffatt

© Wet Paper Publications

On a rocky shore you can see bands of barnacles and bare rock with only algae. These are called dominant species.



Photo Bob Moffatt

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For the intertidal zone, these factors come into play when applying abiotic and biotic limiting factors, with respect to distance from the shore.

For the pelagic, benthic and abyssal environments, depth and light intensity play major roles.

Zone	Distance from shore	Abiotic factor	Application / effect	Example
Supra littoral zone				
Littoral zone				

Zone	Distance from shore	Abiotic factor	Application / effect	Example
Sublittoral zone				
	Application - Competition			

Zone	Distance from shore	Abiotic factor	Application / effect	Example
Pelagic				
Benthic zone				

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References

https://en.wikipedia.org/wiki/Littoral_zoneIntertidal zone

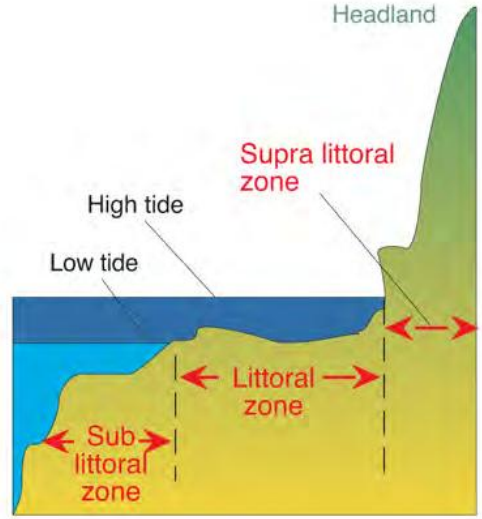
https://en.wikipedia.org/wiki/Intertidal_zoneOceanic zone

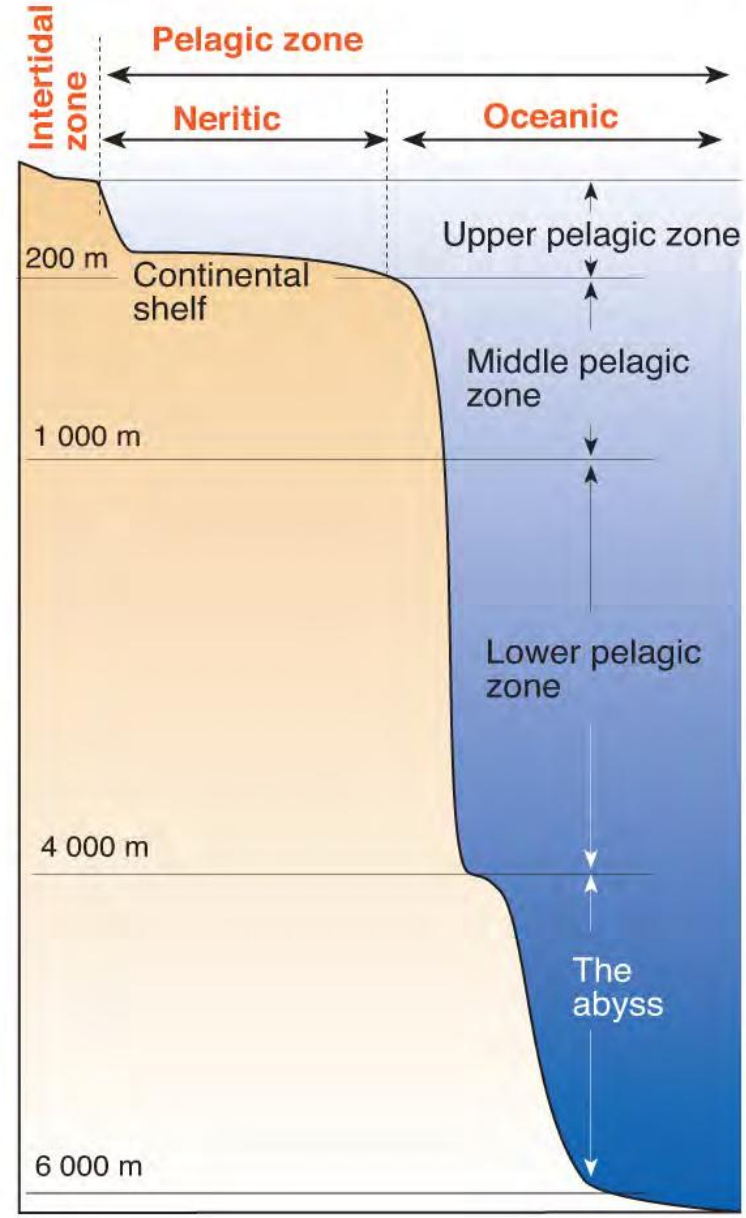
https://en.wikipedia.org/wiki/Oceanic_zone

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Supra littoral zone

Close to shore.
Exposed 14 days due to neap tides

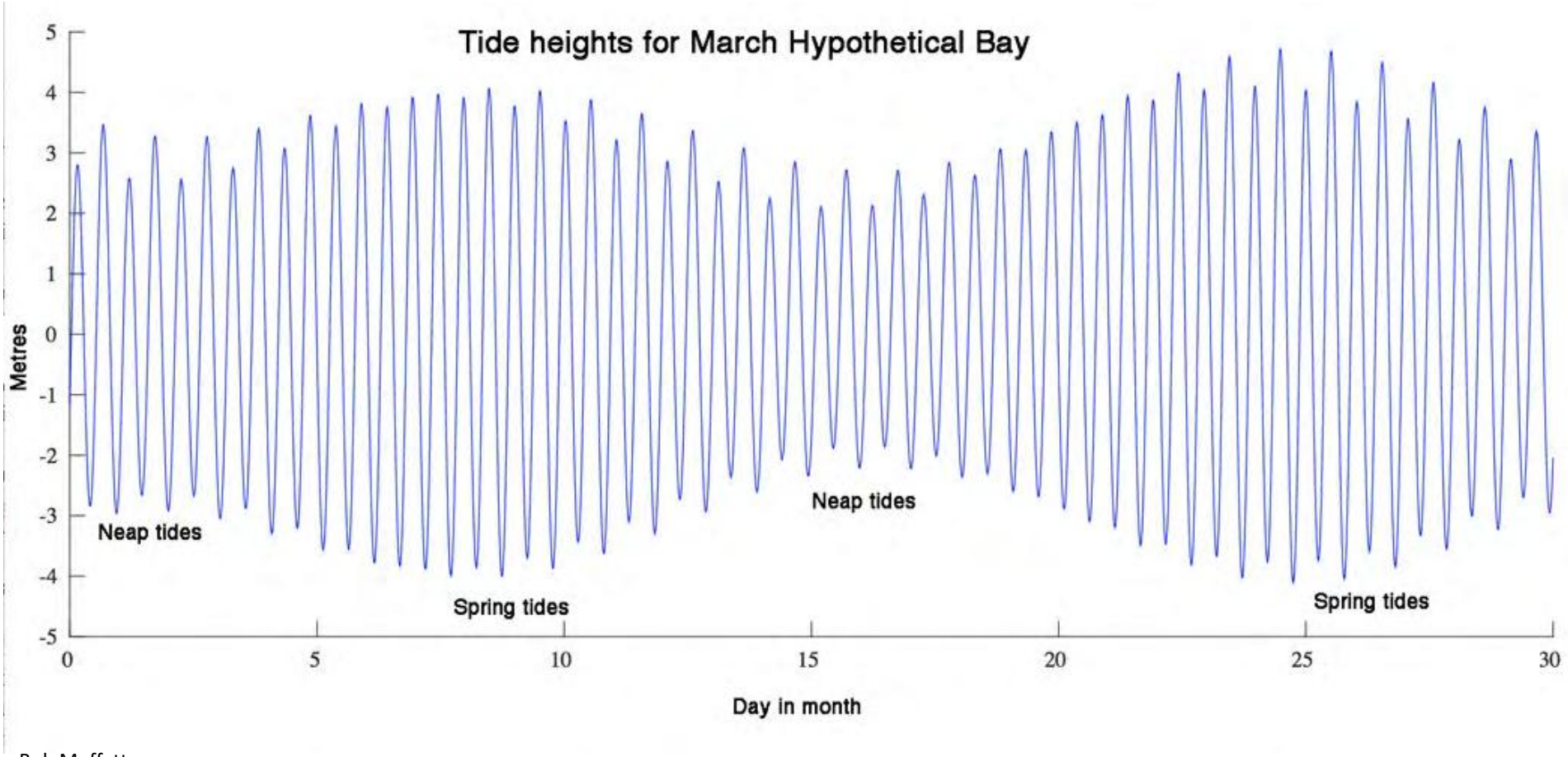




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Tides and storms also play a major factor in controlling zonation.
Spring tides bring water.



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Storms bring spray to the supra littoral zone.



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This means some animals and plants will only get water once every 14 days.
Animals are typically small and have a high tolerance to desiccation (drying out).



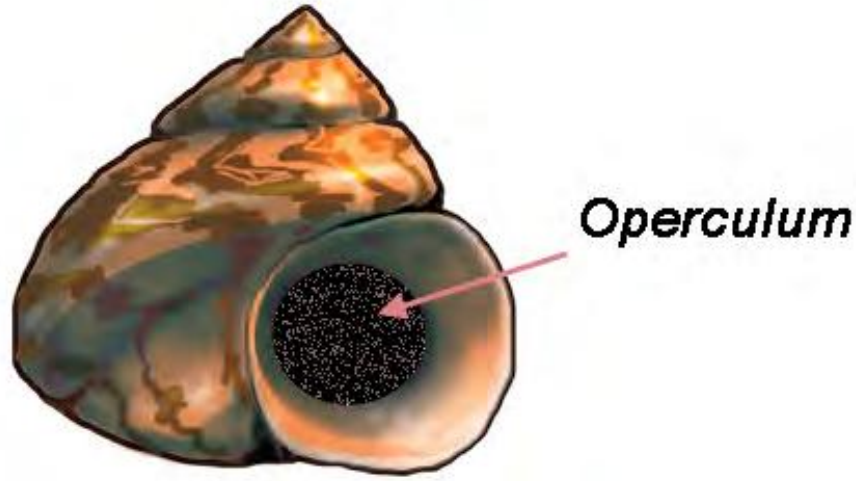
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Shells have special adaptions such as an operculum to keep water in.



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Periwinkles in the supra littoral zone.



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Lichens also dominate on exposed rocks.



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As do pandanas and other salt hardy plants

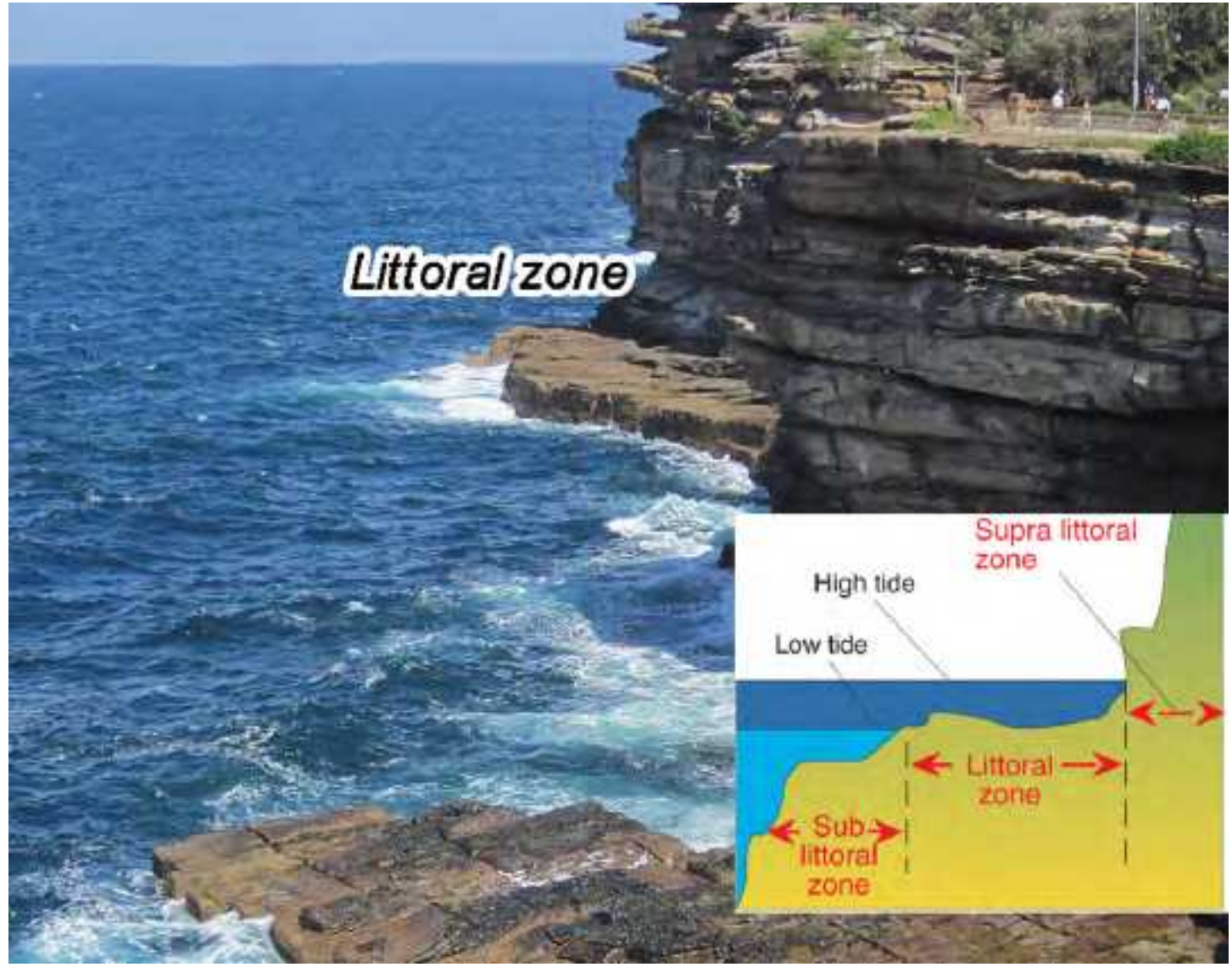


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Littoral zone

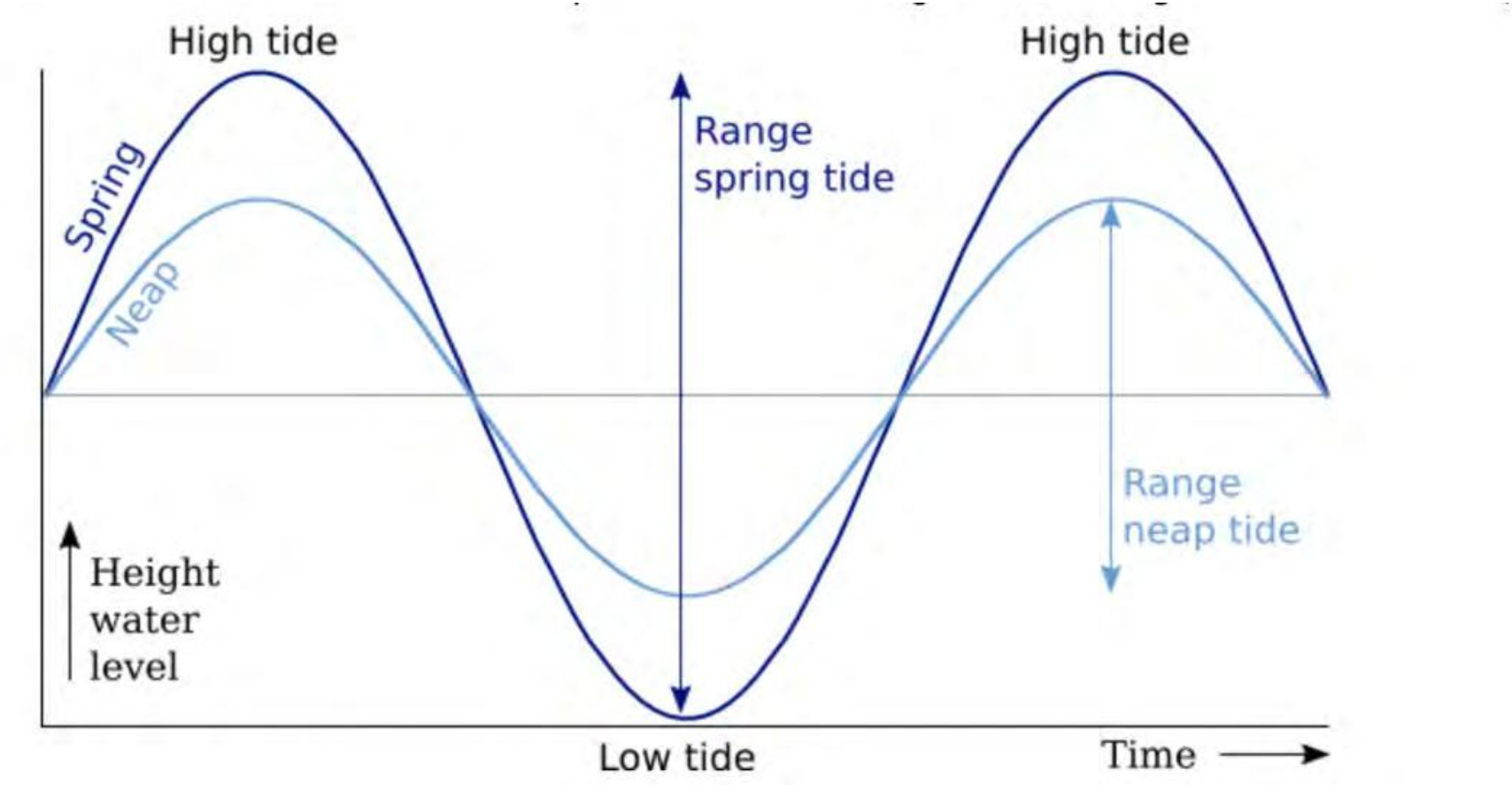
Between
high and low
tide mark.



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Water comes in on a daily basis with daily tides depending on the tidal range.

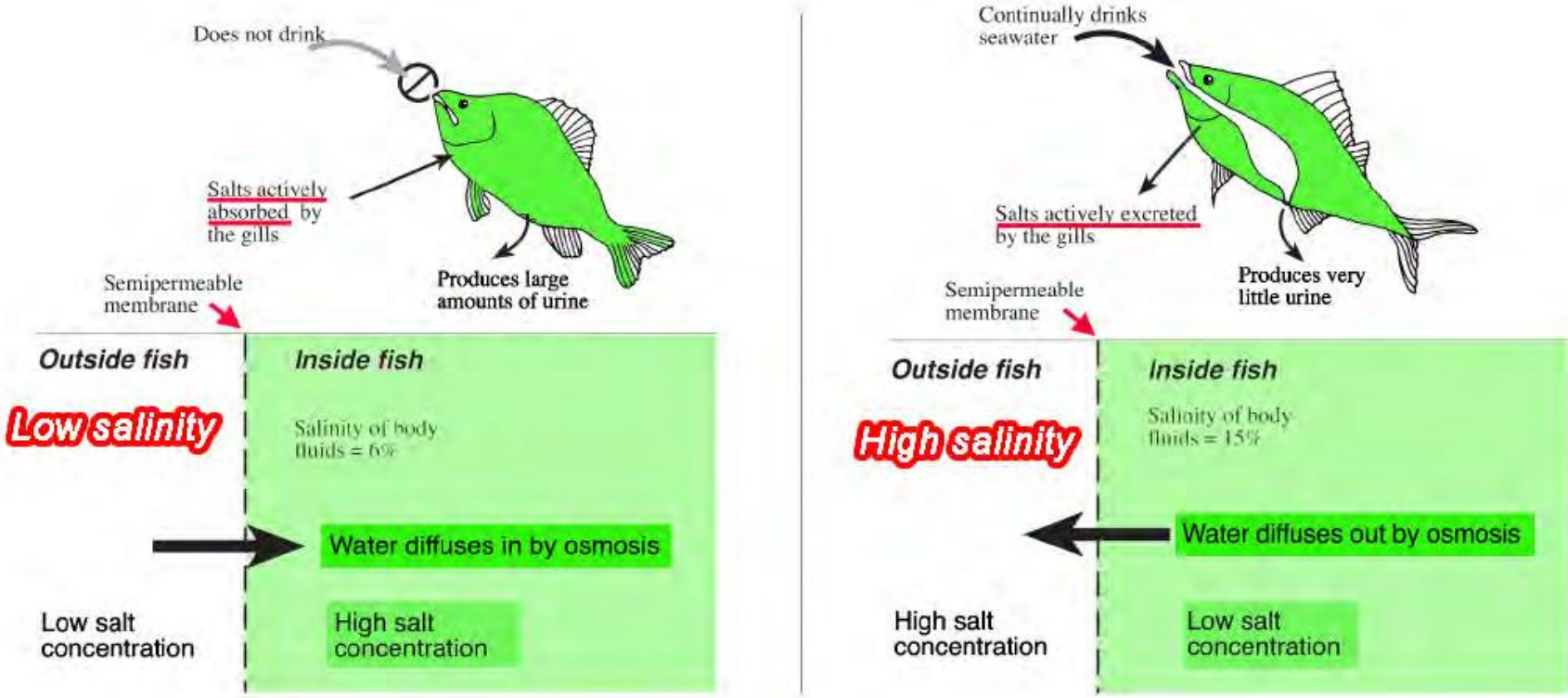


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Salinity and oxygen levels change.

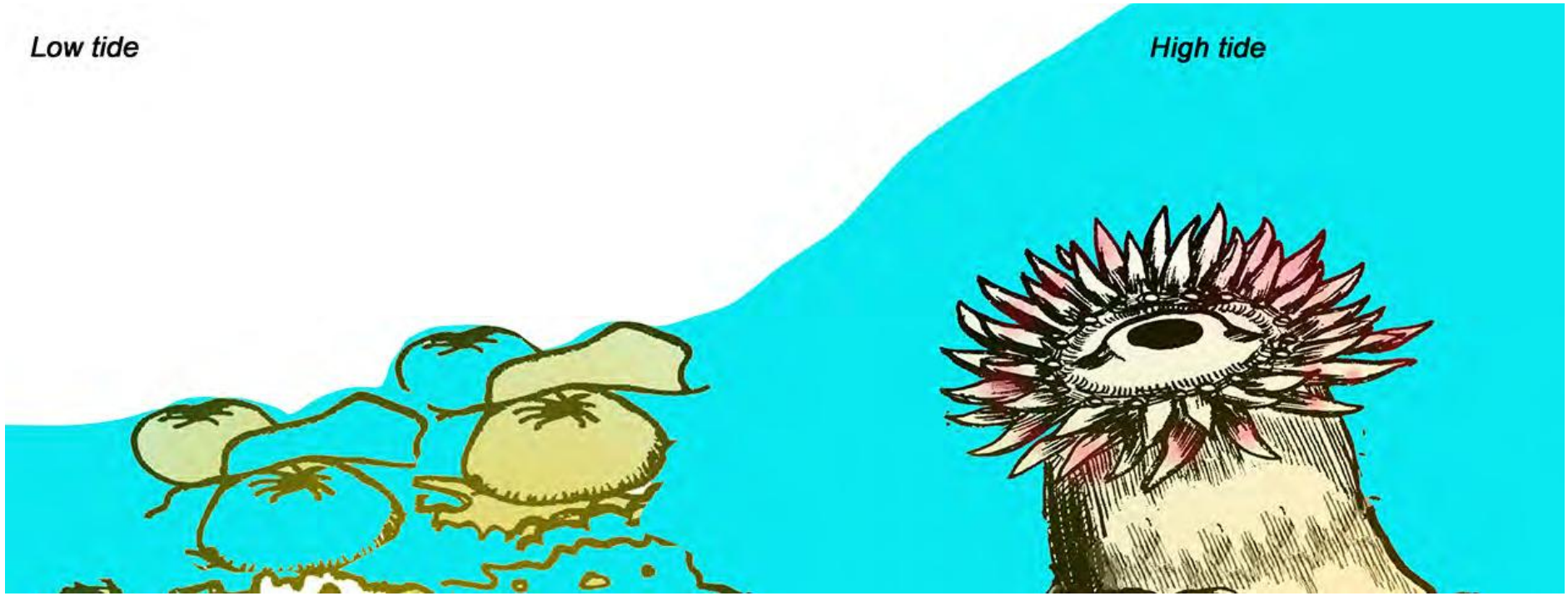
The fact that there is more water with large variations in physical properties creates a zone for animals and plants who have a specific tolerances for these properties.



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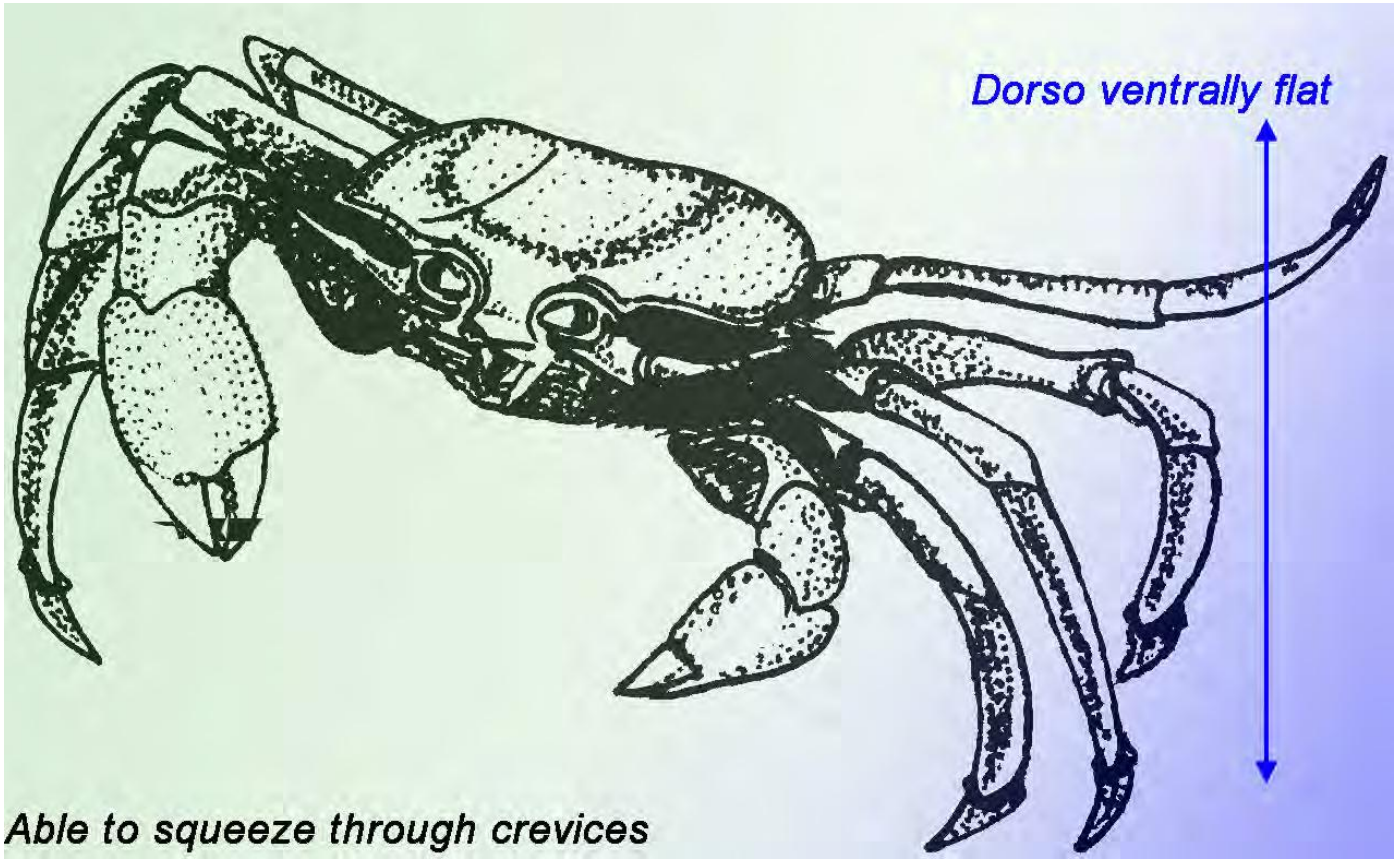
Sea anemone will feed during high tide but then roll up into a ball at low tide and live deep in a crevice to prevent desiccation and being eaten by predators such as crabs.



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Crabs are flat so they can squeeze through crevices.



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They also have sharp claws and jointed legs to prevent them being washed away by waves.



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Algae have a tough outer covering to prevent desiccation.



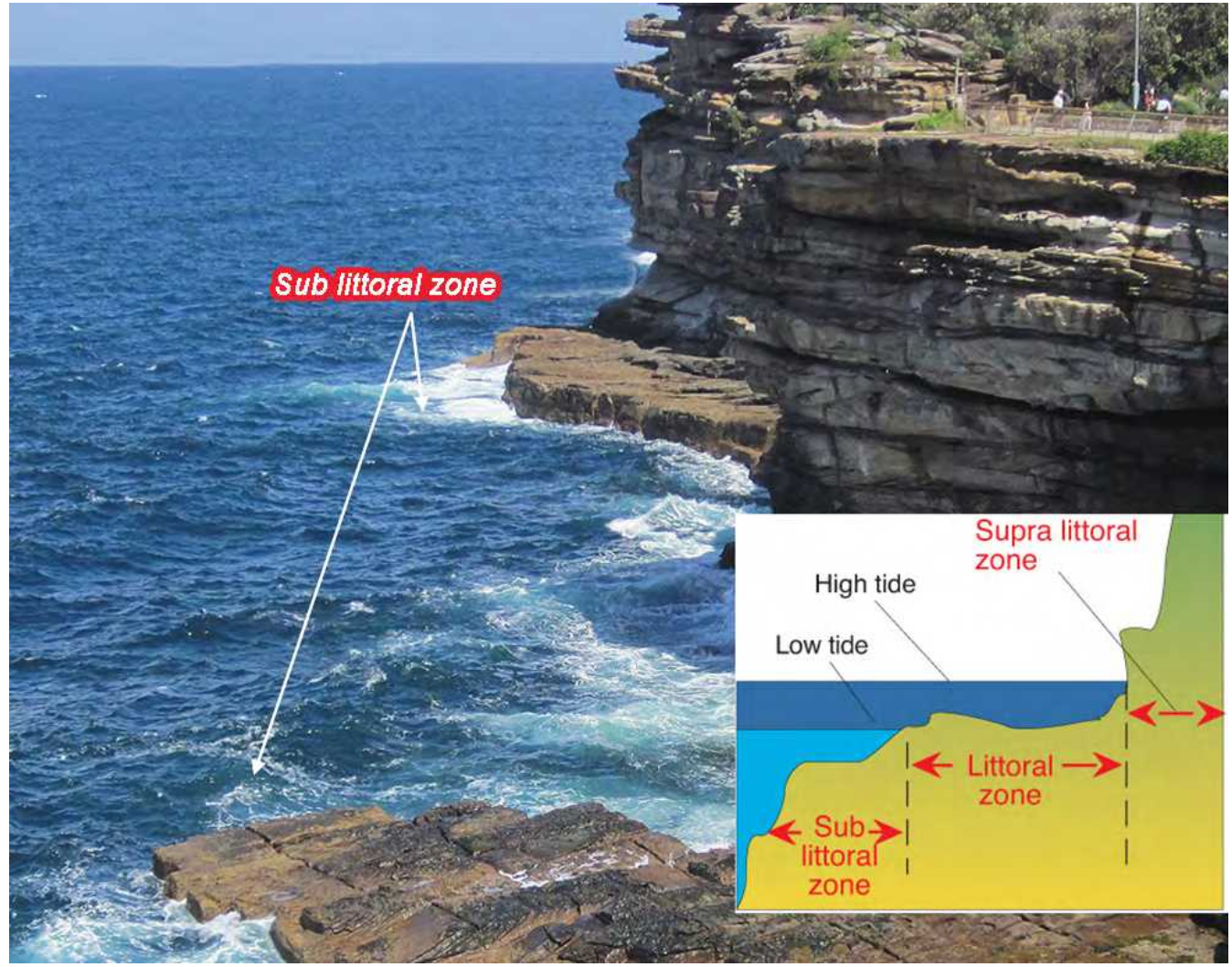
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Sublittoral zone

Below low water.

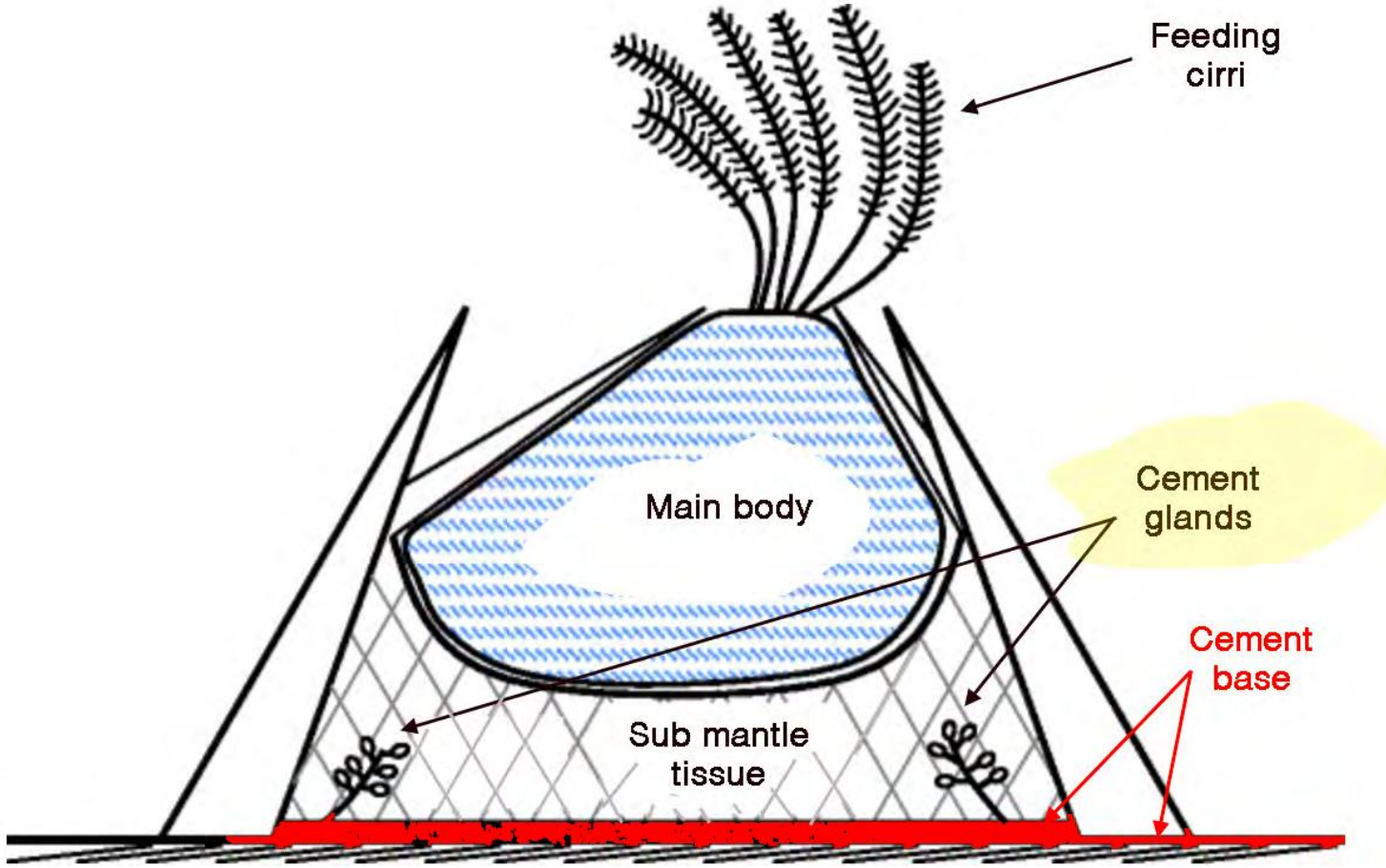
Waves enhanced by cyclones and severe weather events determine what lives in this zone.



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Animals and plants either need to be cemented onto the rocks or have strong suction mechanisms to hang on.
Waves also determine the shape of organisms and the ways they feed themselves.



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Barnacle cement themselves to rocks, disperse wave action by their shape and feed with special appendages as waves recede.



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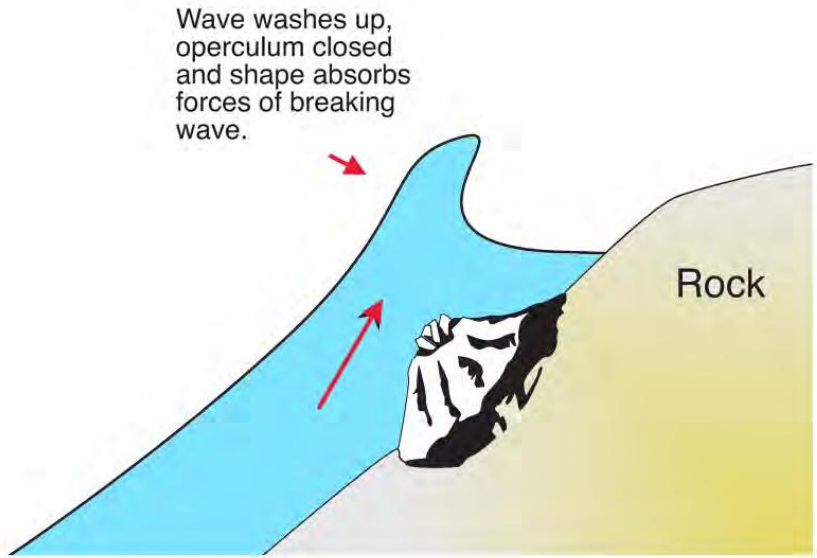
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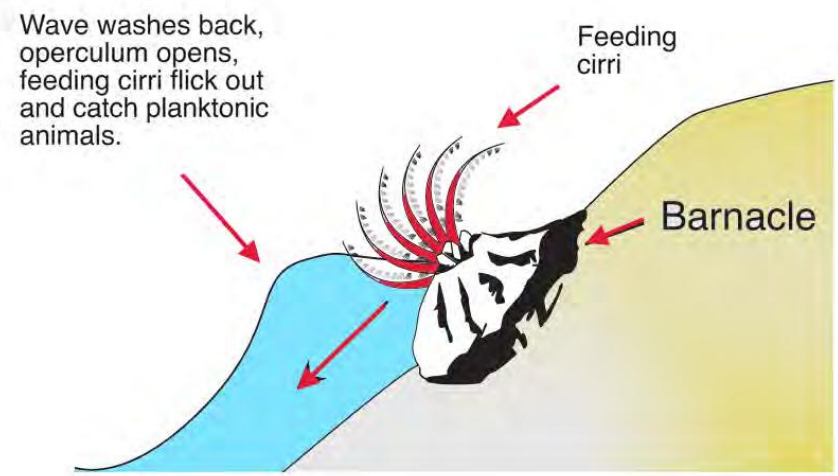


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Barnacles also have feeding cirri which come out as waves retreat to catch plankton and then pull them back in.





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Barnacles feed when waves surge and retract.



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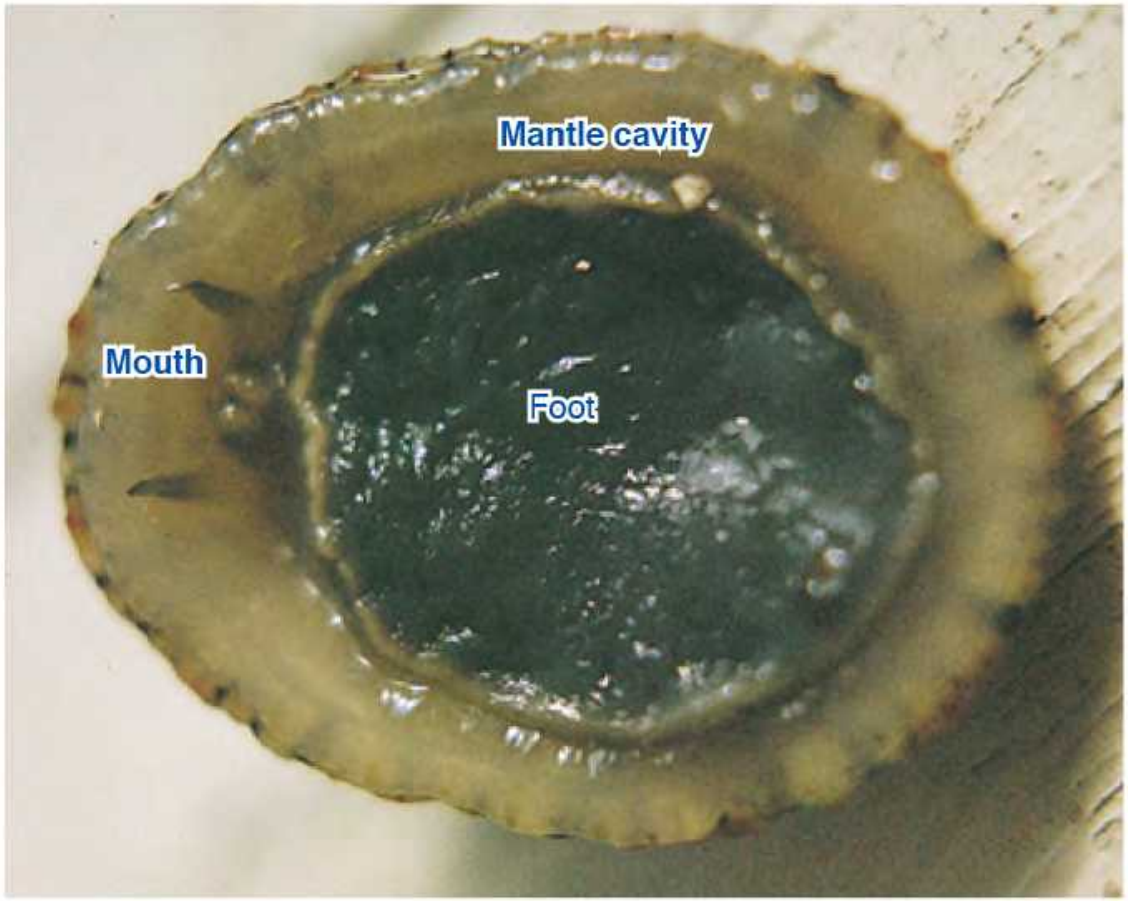
Chitons and limpets have a strong muscular foot to hang on.



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Limpets have a strong muscular foot to hang on.



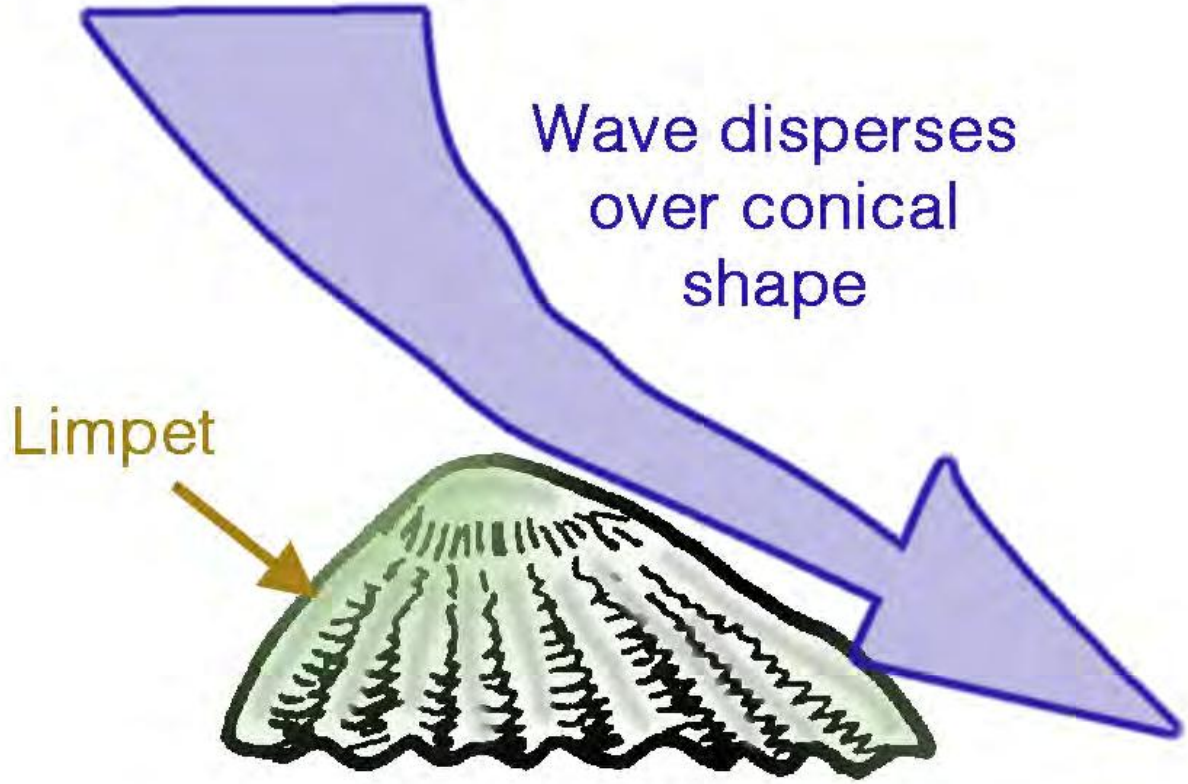




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Their shape helps dissipate wave force.



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Oysters have two shells so they can feed in water and close tight to avoid drying out when the tide goes out.



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Longshore drift can move sand to cover barnacles causing them to suffocate and die. Storms are needed to uncover barnacles to allow them to reproduce and new barnacles to recolonise areas.



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The banding of different types of algae on exposed rocks can be caused by storms exposing rocks by washing away sand.



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Different oxygen levels can then lead to different bands on the newly colonised rocks and barnacles uncovered by a storm event



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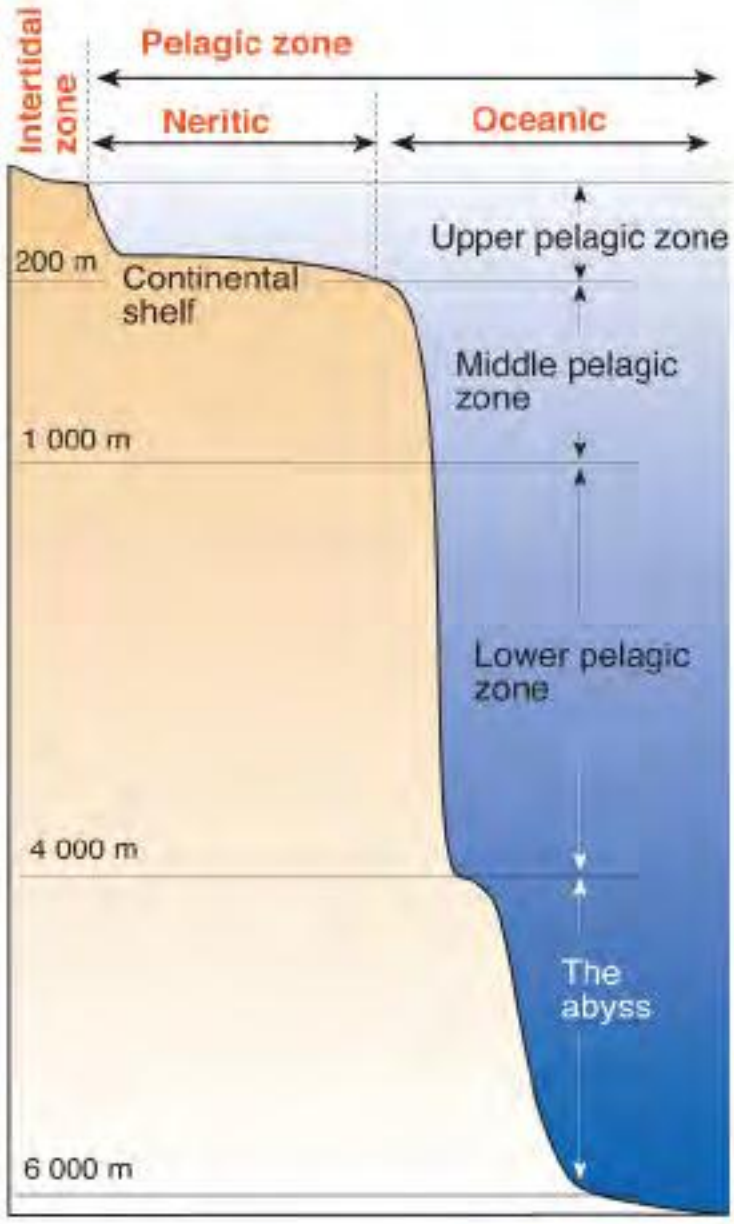
This changing distribution is difficult to see as you leave the intertidal zone and study pelagic, benthic and abyssal zones of the sea.



Remote operated vehicle ROV Hercules

By Brennanphillips at English Wikipedia [Public domain], via Wikimedia Commons

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So, let's move away from land – onto the continental shelf and beyond.

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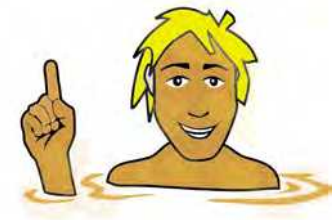
The neretic zone

The neritic zone is the relatively shallow part of the ocean above the drop-off of the continental shelf, approximately 200 metres (660 ft) in depth.

From the point of view of marine biology, it forms a relatively stable and well-illuminated environment for marine life, from plankton up to large fish and corals, while physical oceanography sees it as where the oceanic system interacts with the coast.

Reference:

https://en.wikipedia.org/wiki/Neritic_zone



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From an application of zonation viewpoint you either have to float or swim.



By Unknown - Ocean Explorer/NOAA, Public Domain, https://commons.wikimedia.org/w/index.php?curid=1175637

A closeup of a small mass of sargassum weed.

The numerous small round spheres are floats filled with carbon dioxide.

These provide buoyancy to the algae.

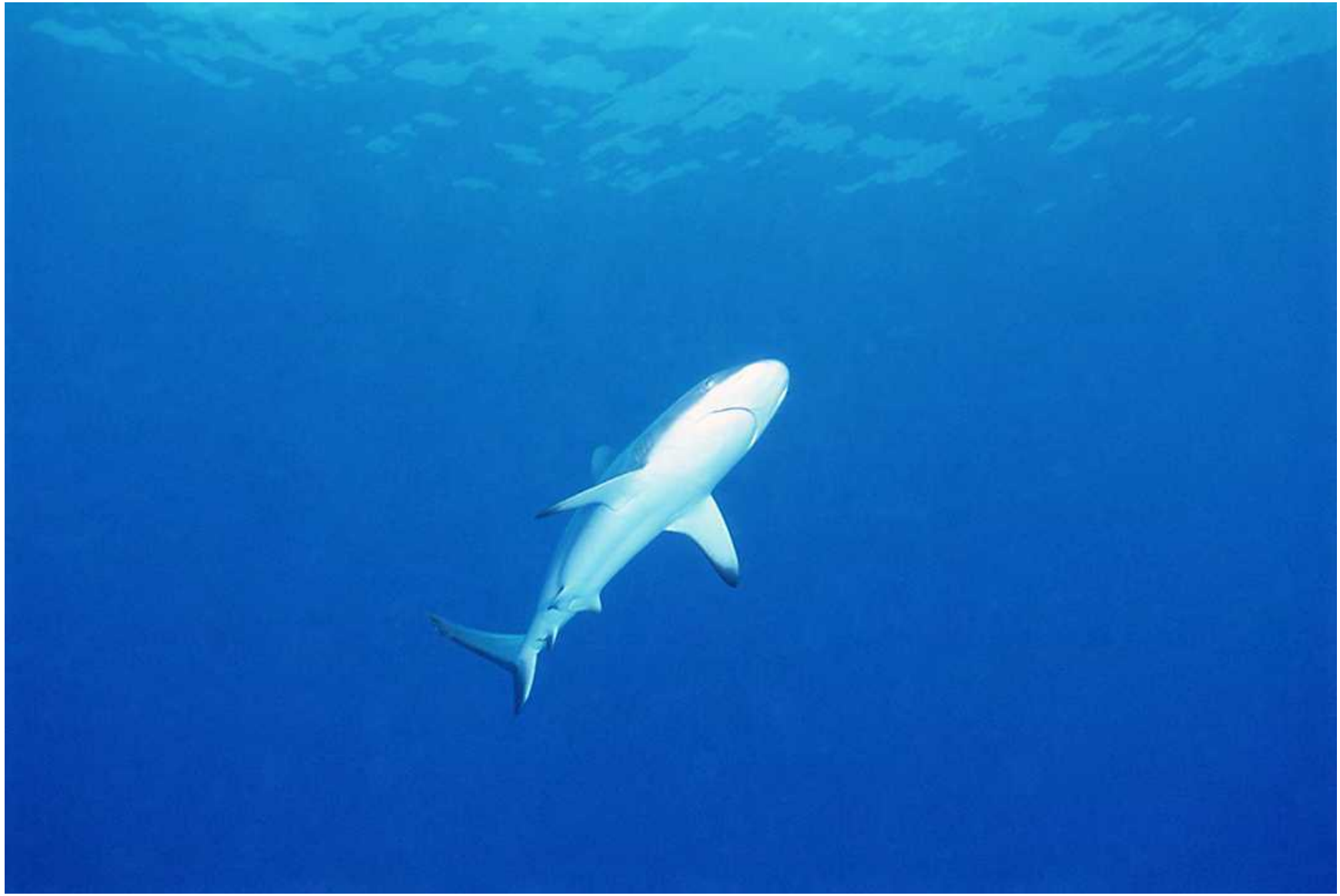
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Sea jellys constantly swim in the neritic zone.



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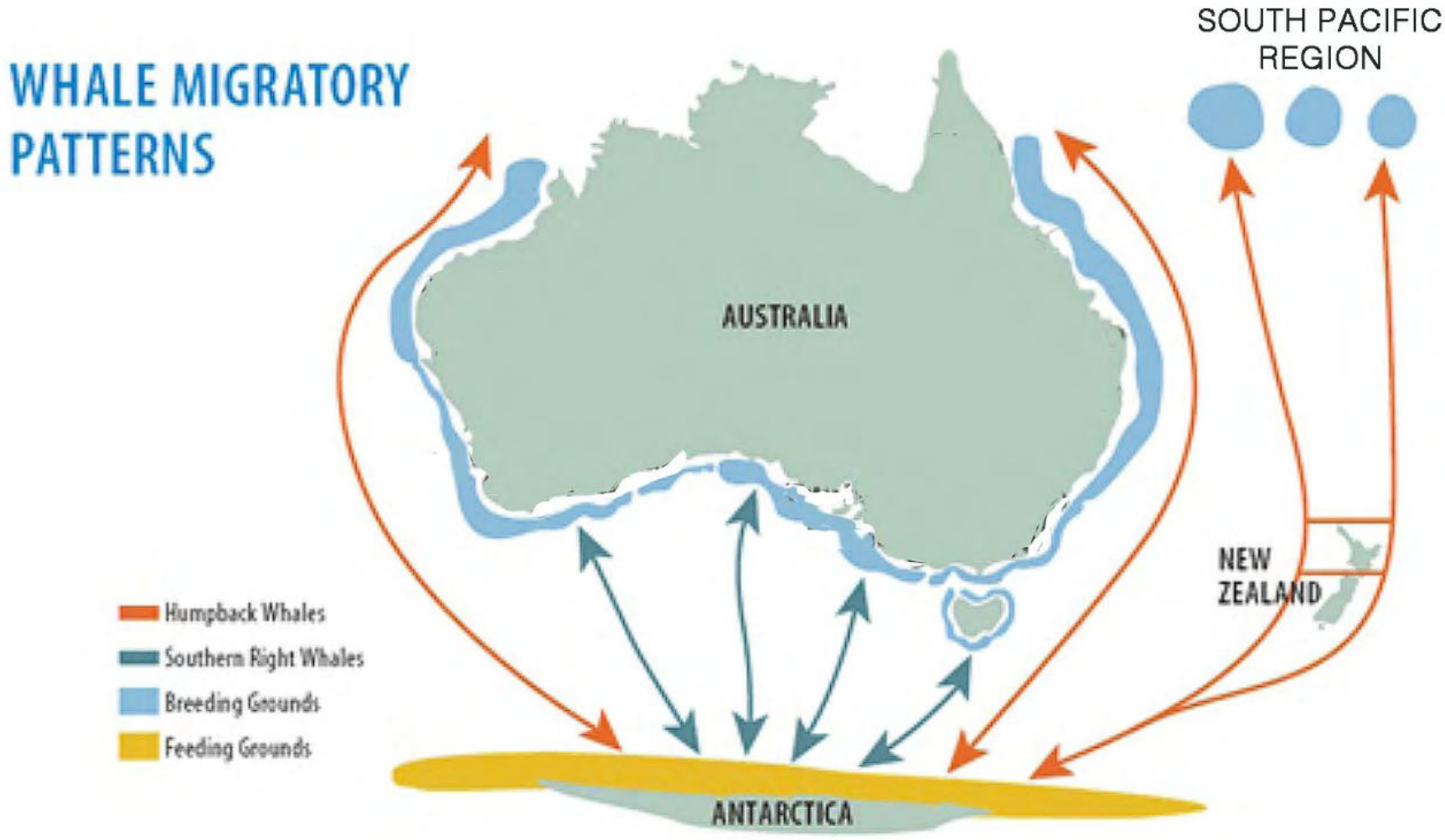
Murray Waite Viewfinder

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Neville Coleman

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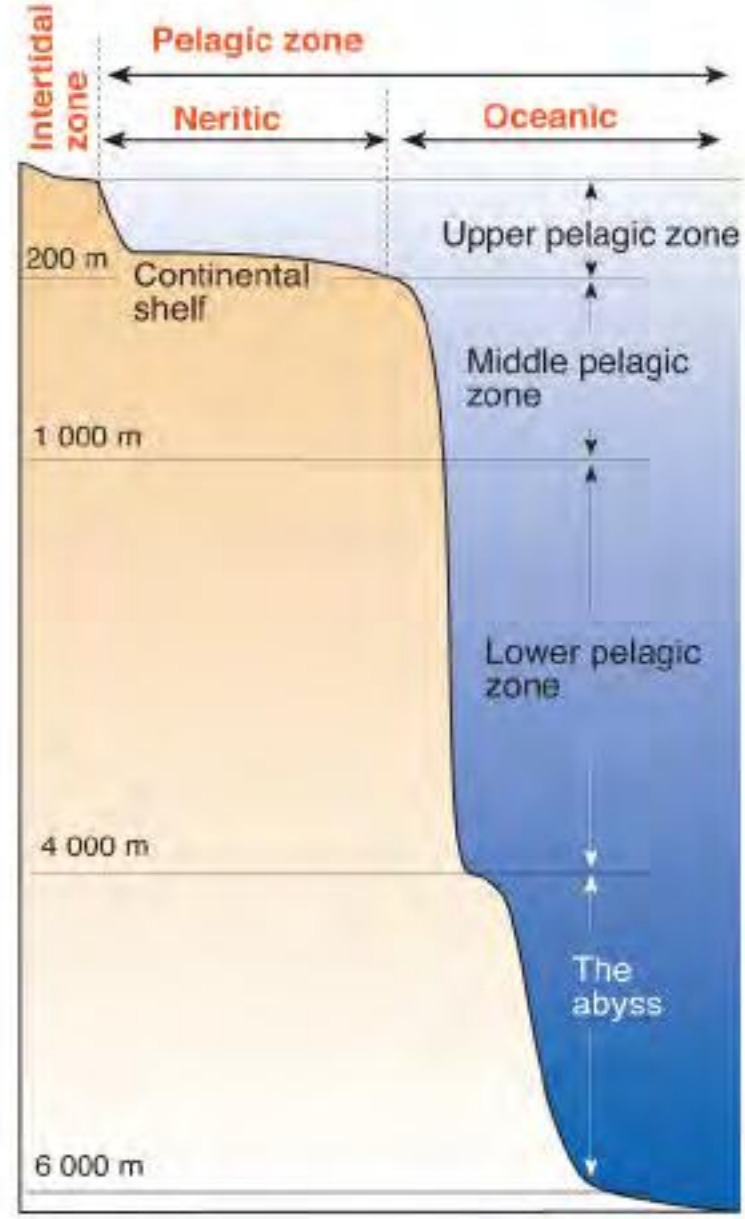
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Oceanic zone is the area of the ocean lying beyond the continental shelf where the water depths drop to below 200 metres in depth.

With a number of layers viz:

- Upper pelagic
- Middle pelagic
- Lower pelagic
- Abyss



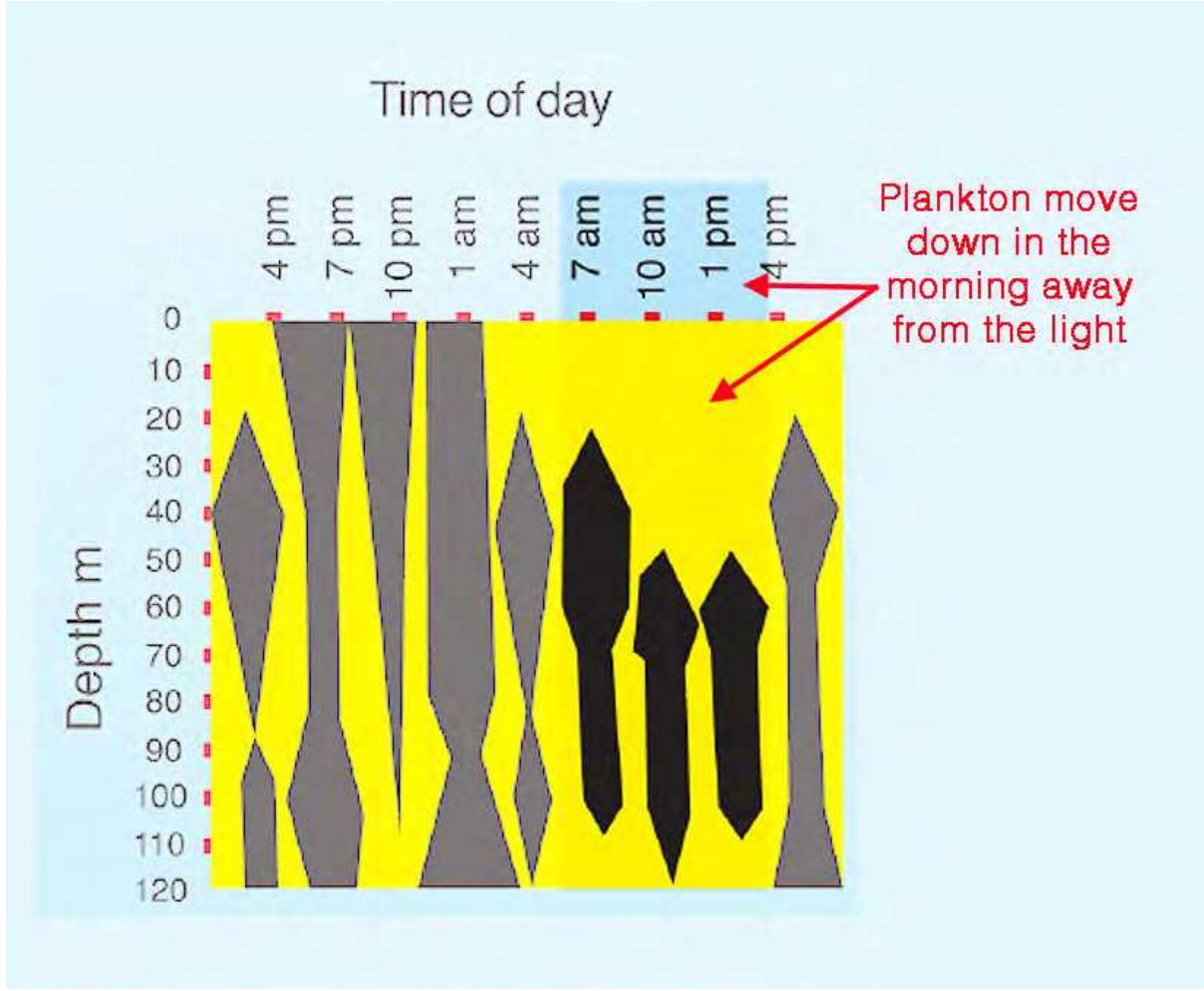
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Marine life must constantly swim to stay afloat.

The vertical migration of plankton could be considered as a band of organisms that move from place to place.

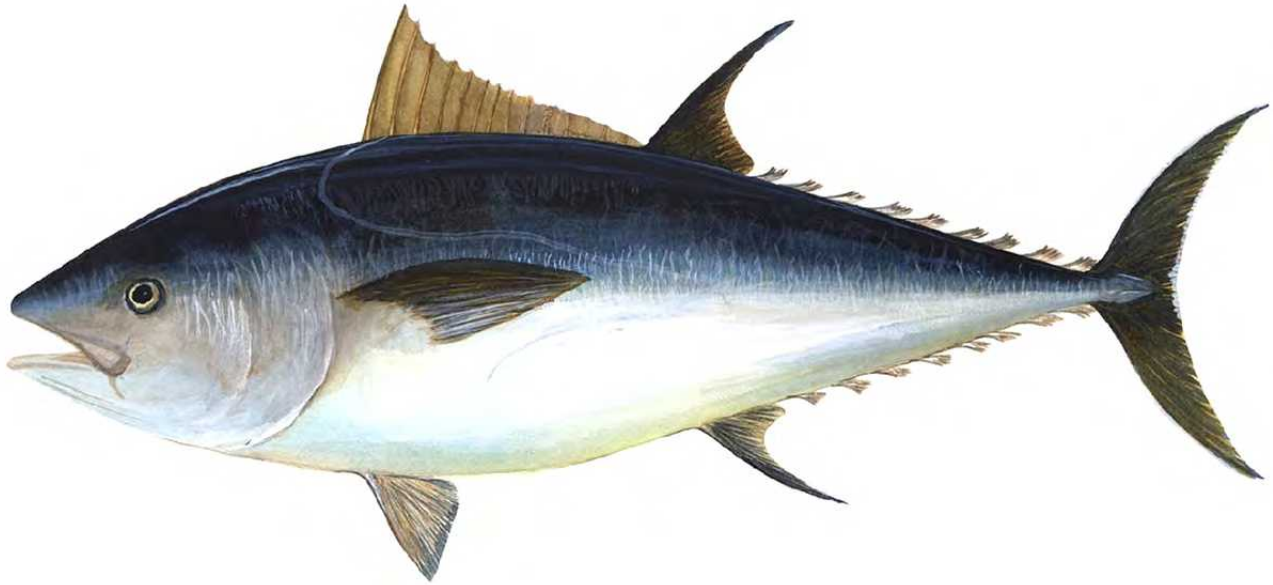
Every day, zooplankton make their way to deep water in the morning and rise as the sun sets. This process, known as ***diel*** (diurnal) vertical migration, is carried out all over the world by marine and freshwater plankton alike.



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The top predators are big, streamlined and move fast.



Wiki – has been sourced but attribution misplaced

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The further you go down the water column the more specialized and fewer animals are found. Squid, cookie cutter sharks and loose jaw fish are found.



Sharyn Madder

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Goblin and cookie cutter sharks





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Hatchet fish and deep sea angler



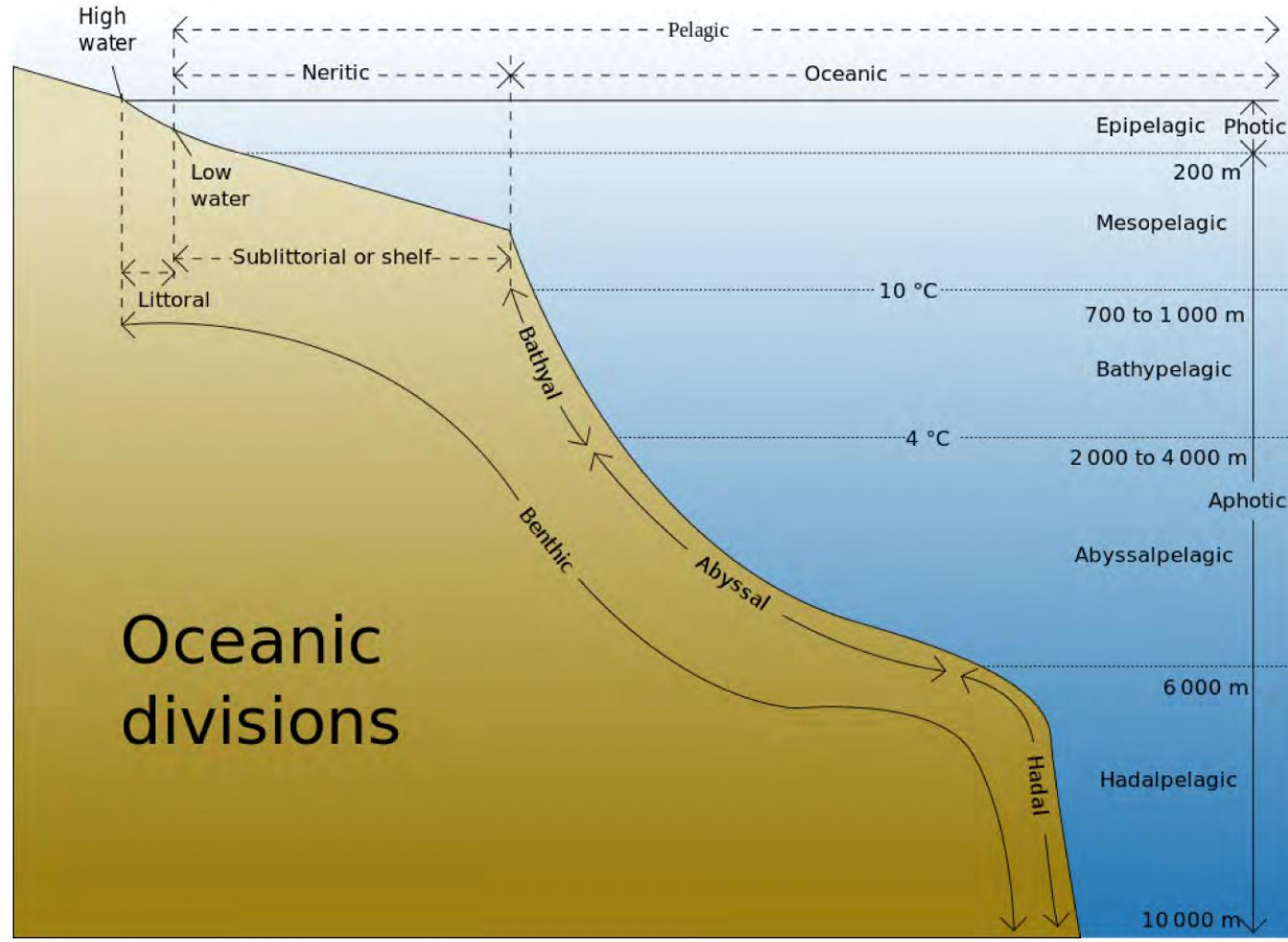


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Benthic zone

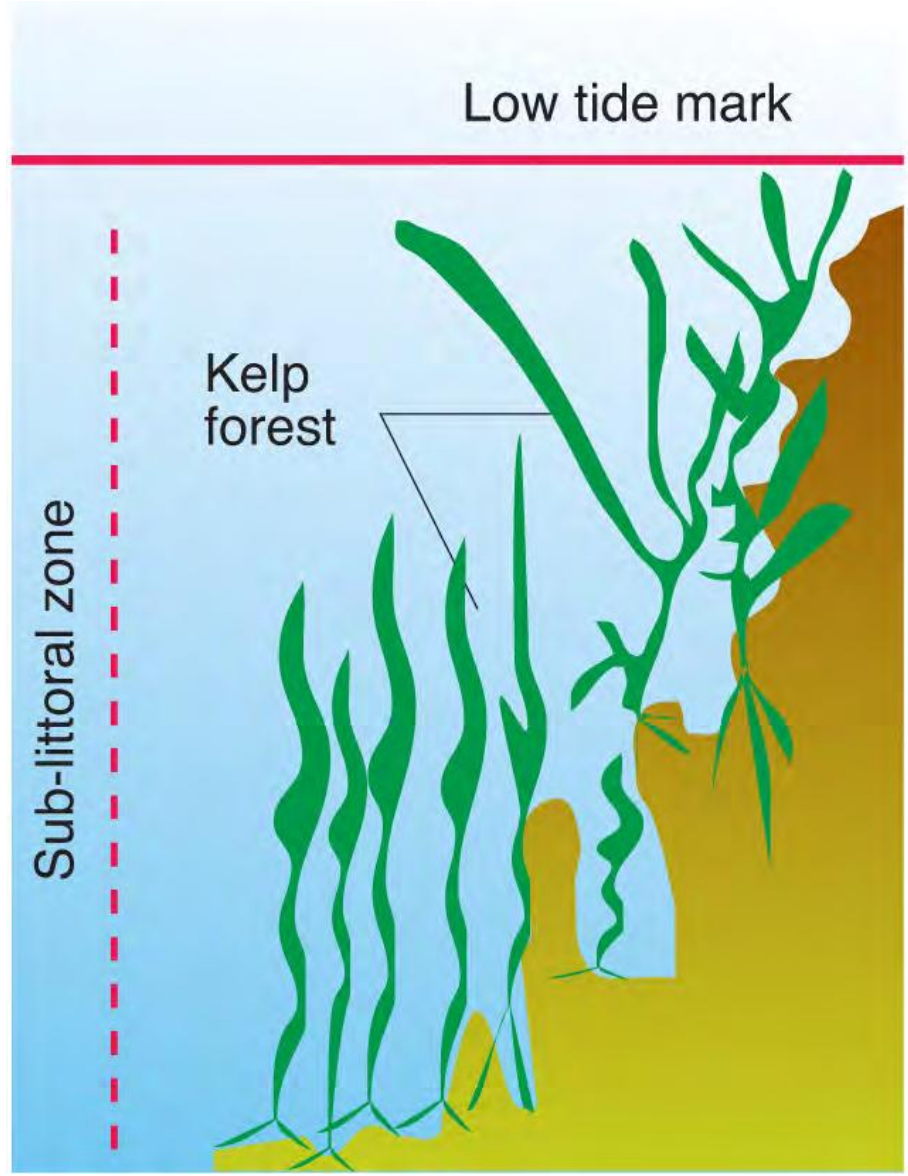
The benthic zone is the ecological region at the lowest level of a body of water such as an ocean or a river, including the sediment surface and some sub-surface layers.



By Chris huh(Original text : K. Aainsqatsi) / K. Aainsqatsi - self-made(Original text : self-made), Public Domain, https://commons.wikimedia.org/w/index.php?curid=3251432

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In temperate regions, giant kelp forests are found in the sub littoral zone.



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Special structures called holdfasts stop the kelp from floating away.



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Organisms living in this zone are called benthos, e.g., the benthic invertebrate community, including crustaceans and polychaetes.



Benthic creatures

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The organisms generally live in close relationship with the substrate bottom and many are permanently attached to the bottom (sessile).

The superficial layer of the soil lining the given body of water, the benthic boundary layer, is an integral part of the benthic zone, as it greatly influences the biological activity that takes place there.



A variety of corals form an outcrop on Flynn Reef, part of the Great Barrier Reef near Cairns, Queensland, AustraliaBy Toby Hudson - Own work, CC BY-SA 3.0, https://commons.wikimedia.org/w/index.php?curid=11137678

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Examples of contact soil layers include sand bottoms, rocky outcrops, coral, and bay mud.

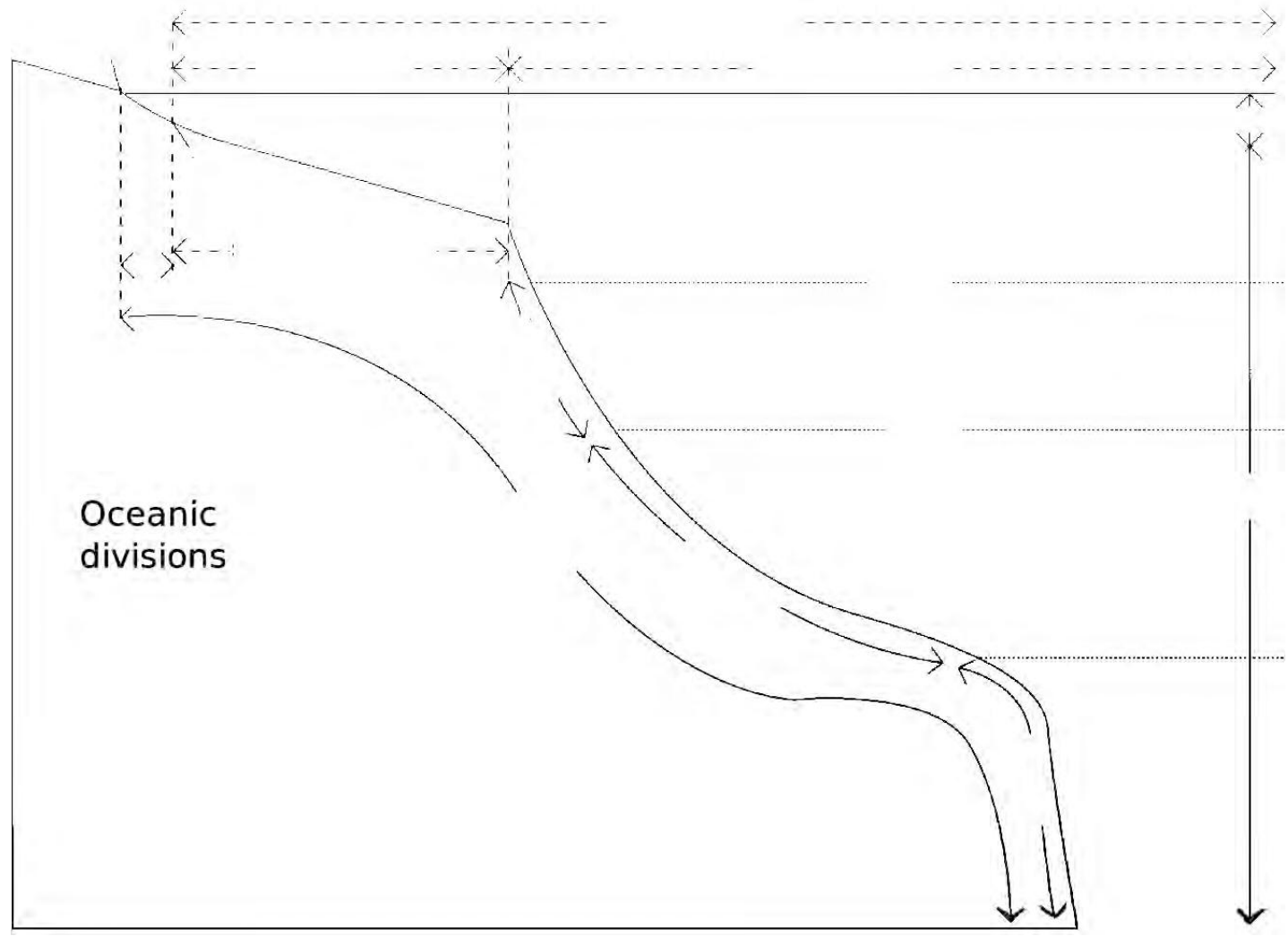


Richardson Bay mudflats show exposed layers of bay mud
By C. Michael Hogan - Own work by the original uploader, Public Domain, https://commons.wikimedia.org/w/index.php?curid=27419946

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Question 1

Use the illustration that follows to complete the following diagram of oceanic divisions.



Modified Bob Moffatt Original by Chris huh(Original text : K. Aainsqatsi) / K. Aainsqatsi - self-made(Original text : self-made), Public Domain, https://commons.wikimedia.org/w/index.php?curid=3251432

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Q2. Complete the following table to apply the concept of zonation to animals from the rocky shore.

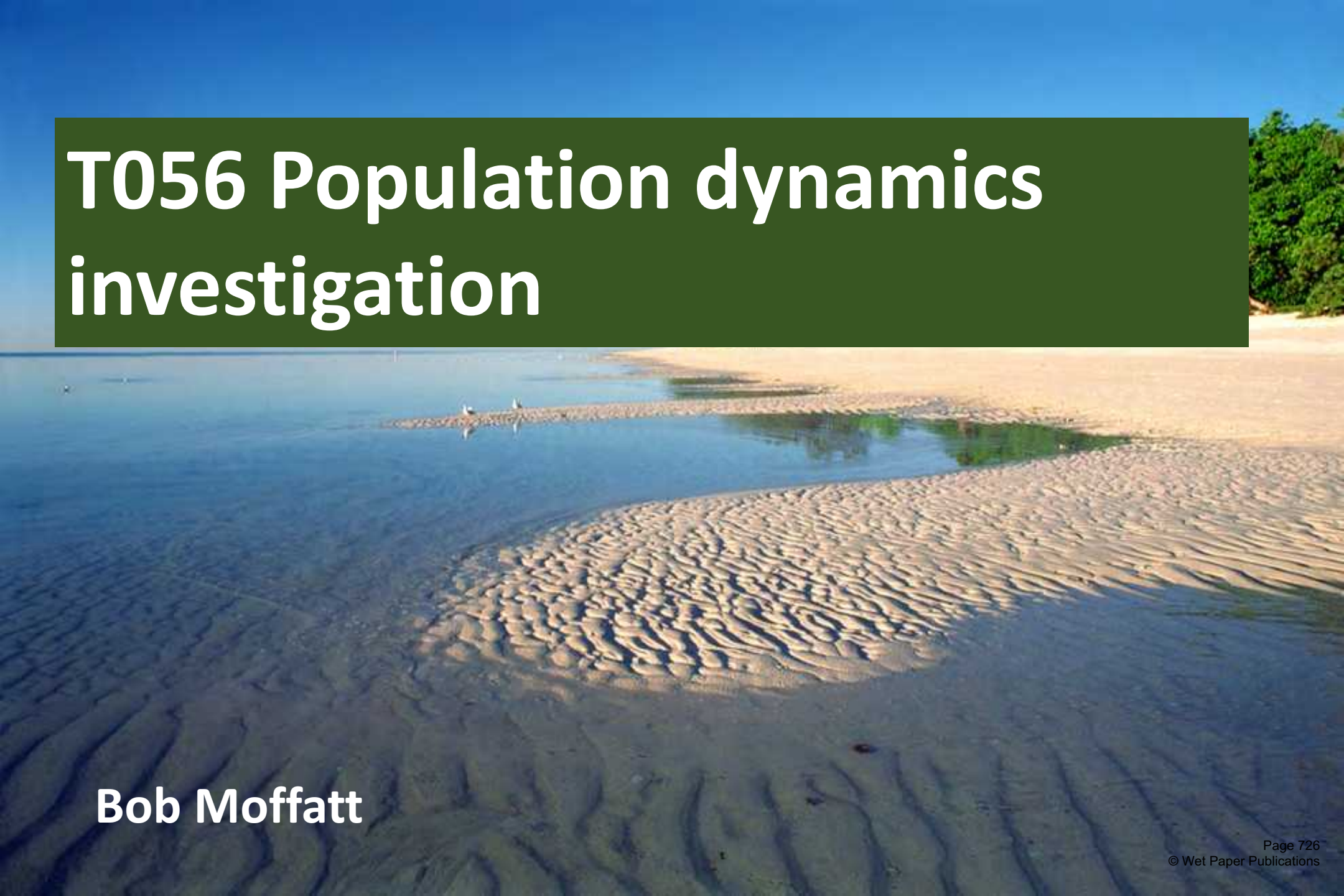
Zone	Distance from shore	Abiotic factor	Application / effect	Example
Supra littoral zone				
Littoral zone				

Zone	Distance from shore	Abiotic factor	Application / effect	Example
Sublittoral zone				
	Application - Competition			

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T056 Population dynamics investigation



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Syllabus statement

At the end of this topic you should be able to ...

At the end of this topic you should be able to **conduct an investigation** to determine factors of population dynamics (e.g. density or distribution) and **assess abiotic** components of a local ecosystem case study.

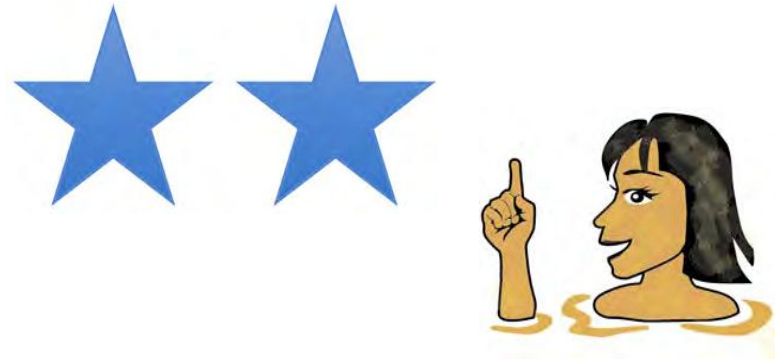




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Conduct

- direct in action or course; manage; organise; carry out



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Assess

measure, determine, evaluate, estimate or make a judgment about the value, quality, outcomes, results, size, significance, nature or extent of something.

Notes

Emphasis should be placed on assessing the processes and limitations of the chosen technique (e.g. quadrat, transect).

When you identify and describe marine species, you should use field guides and identification keys.



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Rocky shore investigation

Equipment

Nitrate kit



Phosphate kit



Salinity meter



Profile stick



Transect square



Temperature probe





Dissolved oxygen meter

pH meter



Digital Anemometer



Waterproof camera



Supply companies (various sources)

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Water collection bottle – Version A



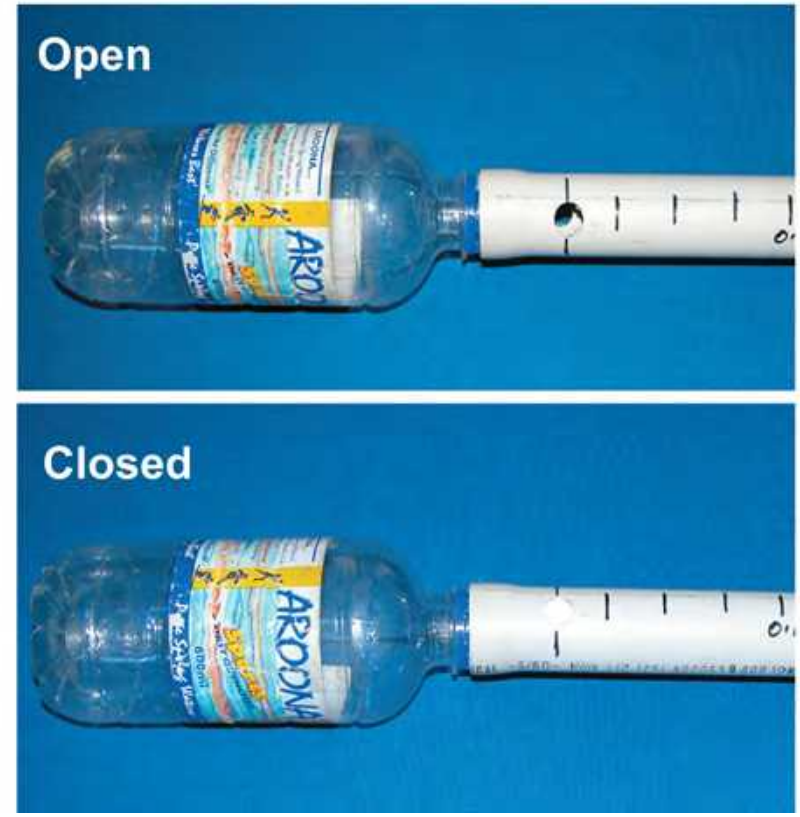


Mick O'Connor
Ballina SHS
2012

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Equipment

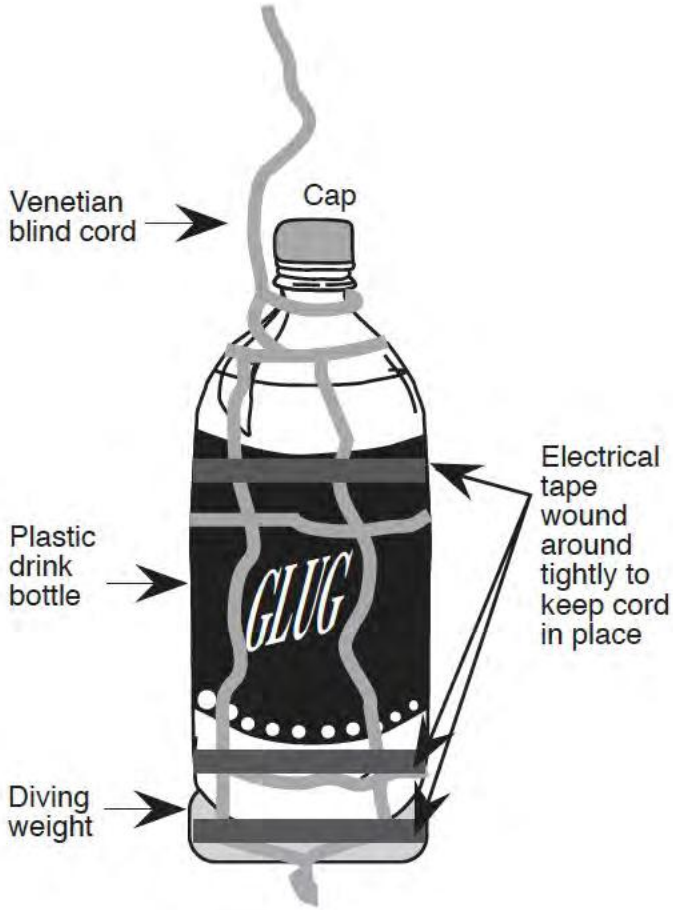




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Water collection bottle – Version B



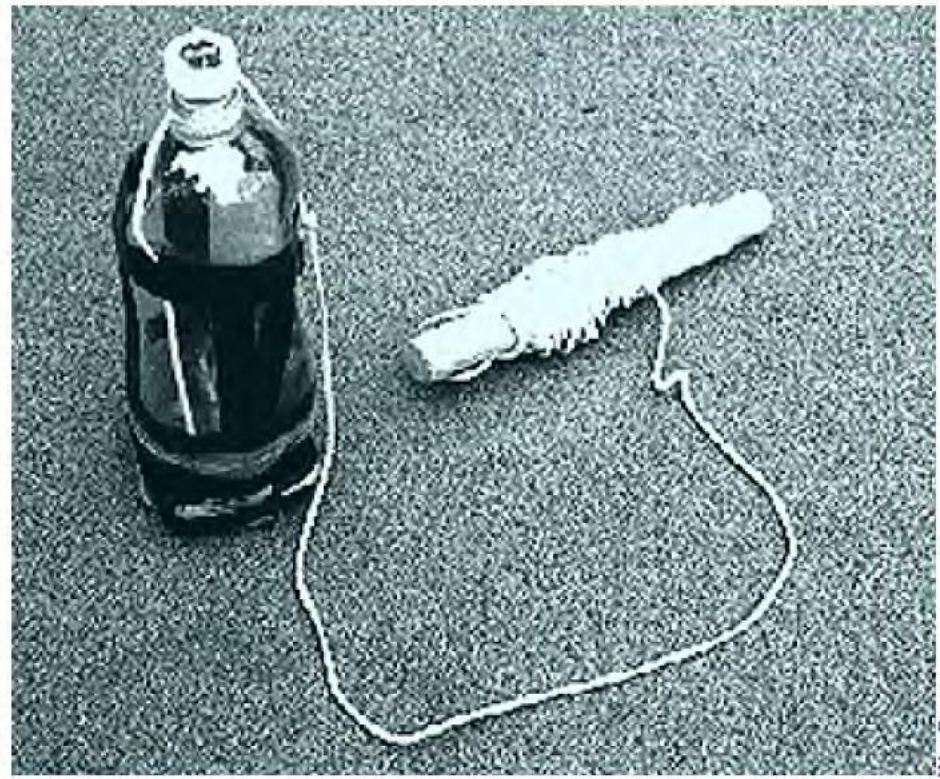


Figure 47.4 Homemade water sampling bottle

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Field thermometer – low cost

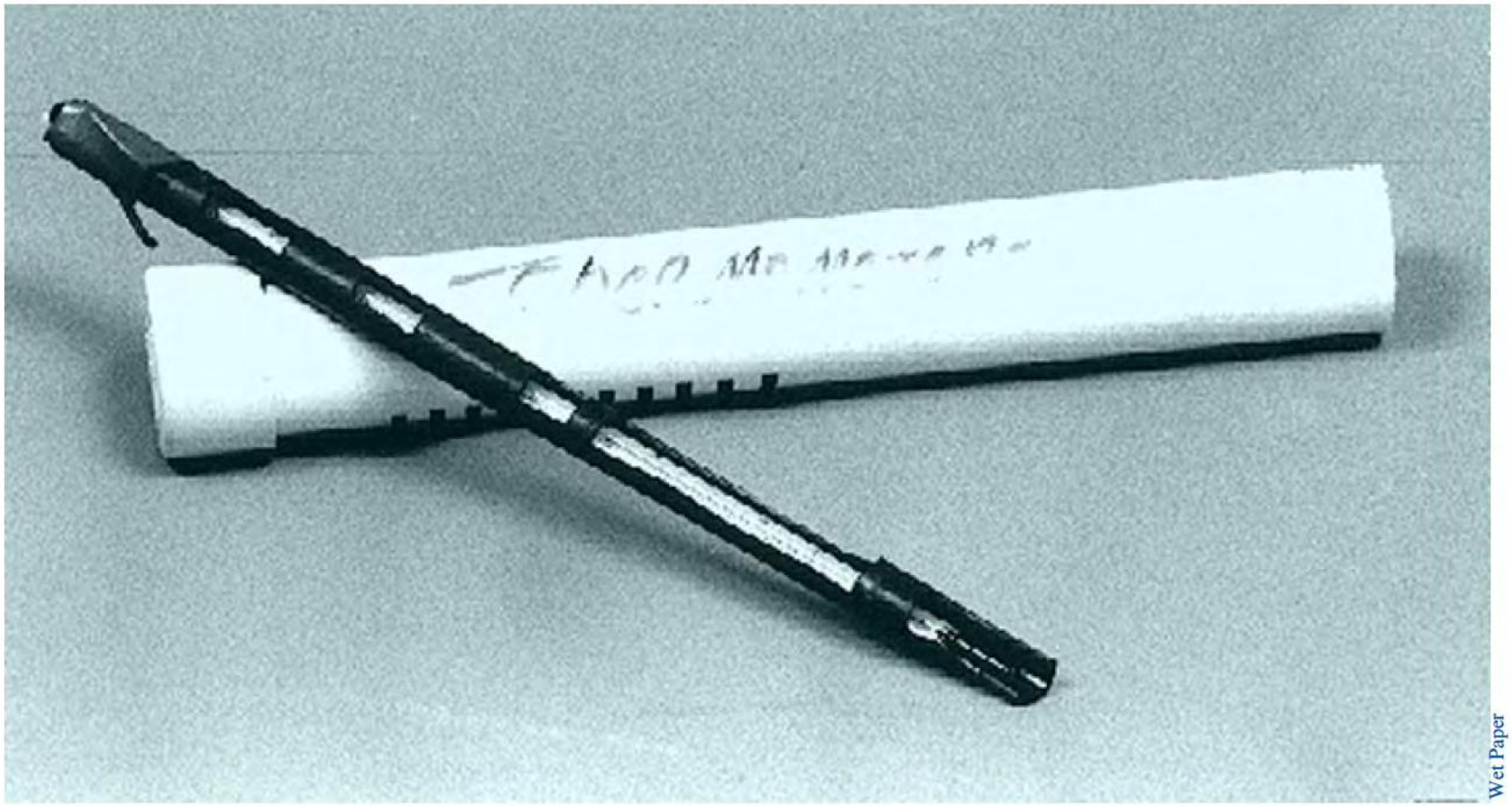


Figure 47.7 Home made field thermometer. A number can be stored in some sink drain pipe with a cap at each end.

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Benowa SHS
1985

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Biotic data equipment	Use	Assessment – points to consider
Digital camera (water proof)	Photograph organisms and study site	Battery charged, file size selected. Backup plan in place
Transect square	Estimate population size	All squares equal. Methods of random sampling selected
Note pad and pencil	Record data and make drawings	
Abiotic data equipment	Measures	
Profile metre stick	Heights to .01 of a meter	
Temperature probe	Temperature to .1 oC	
Oxygen probe	Concentration to .01 mg/l	
Nitrate kit	Concentration to .1 mg/L	
Salinity meter	Concentration to .1 mg/L	
pH probe	pH from 0.0 to 14.0	
Anemometer	Wind speed km/hr	

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Conduct

Select a good site.





Good site – good day. Bad site - bad day.

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This site is good because of:

- good emergency access helicopter, 4W drive,
- good visibility for safety officer observers,
- large study area at low tide means groups are not going to fall over each other,
- easy beach access for carrying equipment,
- the waves are not going to crash on the rocks in the intertidal zone.



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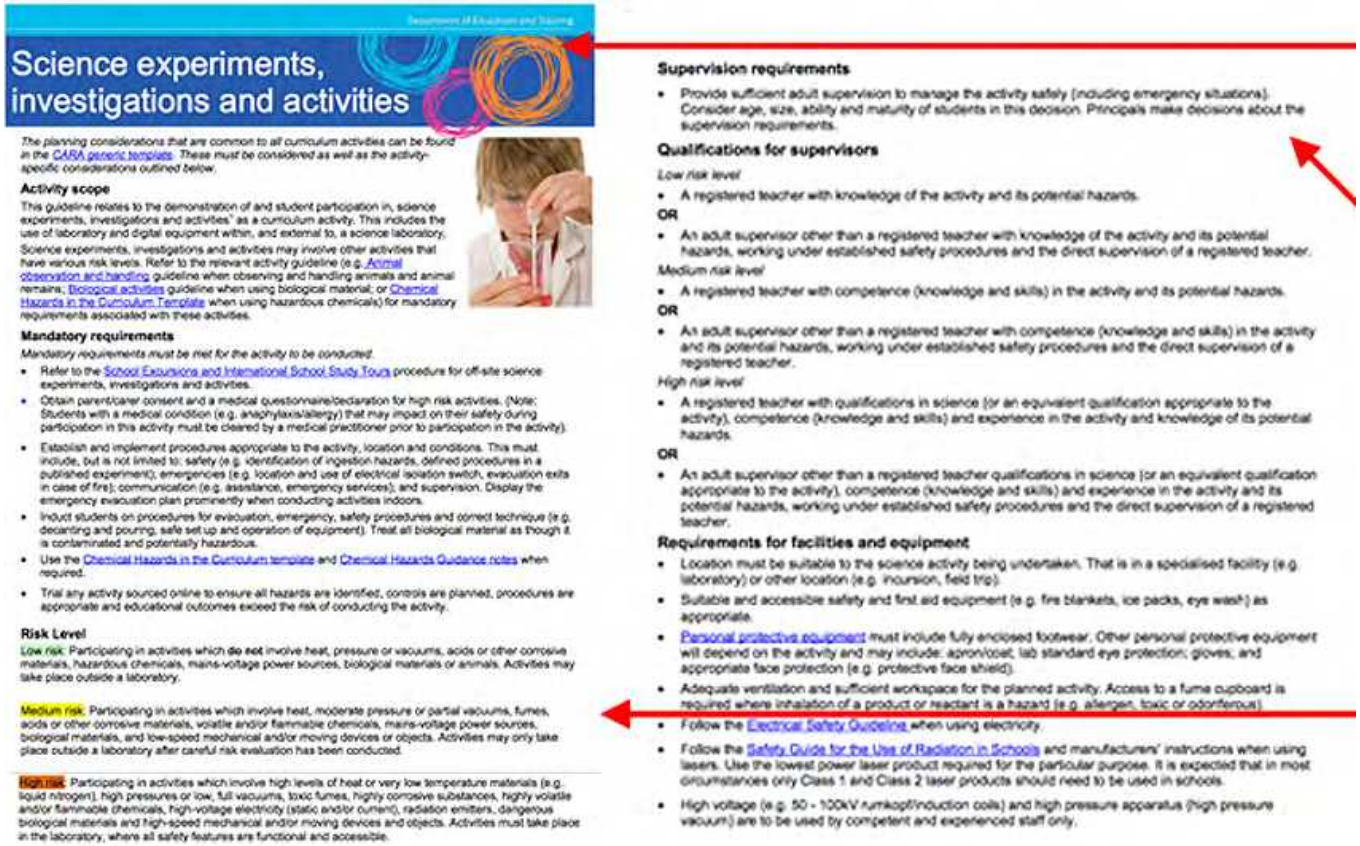
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Conduct

Risk assessment

You must read:

http://education.qld.gov.au/curriculum/carmg/pdf/science-experiments-activities.pdf



Science experiments, investigations and activities

The planning considerations that are common to all curriculum activities can be found in the CARA generic template. These must be considered as well as the activity-specific considerations outlined below.

Activity scope

This guideline relates to the demonstration of and student participation in, science experiments, investigations and activities" as a curriculum activity. This includes the use of laboratory and digital equipment within, and external to, a science laboratory.

Science experiments, investigations and activities may involve other activities that have various risk levels. Refer to the relevant activity guideline (e.g. Animal observation and handling guideline when observing and handling animals and animal remains; Biological activities guideline when using biological material; or Chemical Hazards in the Curriculum Template when using hazardous chemicals) for mandatory requirements associated with these activities.

Mandatory requirements

Mandatory requirements must be met for the activity to be conducted.

- Refer to the School Excursions and International School Study Tours procedure for off-site science experiments, investigations and activities.
- Obtain parent/carer consent and a medical questionnaire/declaration for high risk activities. (Note: Students with a medical condition (e.g. anaphylaxis/allergy) that may impact on their safety during participation in this activity must be cleared by a medical practitioner prior to participation in the activity).
- Establish and implement procedures appropriate to the activity, location and conditions. This must include, but is not limited to: safety (e.g. identification of ingestion hazards, defined procedures in a published experiment); emergencies (e.g. location and use of electrical isolation switch, evacuation exits in case of fire); communication (e.g. assistance, emergency services); and supervision. Display the emergency evacuation plan prominently when conducting activities indoors.
- Induct students on procedures for evacuation, emergency, safety procedures and correct technique (e.g. decanting and pouring, safe set up and operation of equipment). Treat all biological material as though it is contaminated and potentially hazardous.
- Use the Chemical Hazards in the Curriculum template and Chemical Hazards Guidance notes when required.
- Trial any activity sourced online to ensure all hazards are identified, controls are planned, procedures are appropriate and educational outcomes exceed the risk of conducting the activity.

Risk Level

Low risk: Participating in activities which **do not** involve heat, pressure or vacuums, acids or other corrosive materials, hazardous chemicals, mains-voltage power sources, biological materials or animals. Activities may take place outside a laboratory.

Medium risk: Participating in activities which involve heat, moderate pressure or partial vacuums, fumes, acids or other corrosive materials, volatile and/or flammable chemicals, mains-voltage power sources, biological materials, and low-speed mechanical and/or moving devices or objects. Activities may only take place outside a laboratory after careful risk evaluation has been conducted.

High risk: Participating in activities which involve high levels of heat or very low temperature materials (e.g. liquid nitrogen), high pressures or low, full vacuums, toxic fumes, highly corrosive substances, highly volatile and/or flammable chemicals, high-voltage electricity (static and/or current), radiation emitters, dangerous biological materials and high-speed mechanical and/or moving devices and objects. Activities must take place in the laboratory, where all safety features are functional and accessible.

Supervision requirements

- Provide sufficient adult supervision to manage the activity safely (including emergency situations). Consider age, size, ability and maturity of students in this decision. Principals make decisions about the supervision requirements.

Qualifications for supervisors

Low risk level

- A registered teacher with knowledge of the activity and its potential hazards.

OR

- An adult supervisor other than a registered teacher with knowledge of the activity and its potential hazards, working under established safety procedures and the direct supervision of a registered teacher.

Medium risk level

- A registered teacher with competence (knowledge and skills) in the activity and its potential hazards.

OR

- An adult supervisor other than a registered teacher with competence (knowledge and skills) in the activity and its potential hazards, working under established safety procedures and the direct supervision of a registered teacher.

High risk level

- A registered teacher with qualifications in science (or an equivalent qualification appropriate to the activity), competence (knowledge and skills) and experience in the activity and knowledge of its potential hazards.

OR

- An adult supervisor other than a registered teacher qualifications in science (or an equivalent qualification appropriate to the activity), competence (knowledge and skills) and experience in the activity and its potential hazards, working under established safety procedures and the direct supervision of a registered teacher.

Requirements for facilities and equipment

- Location must be suitable to the science activity being undertaken. That is in a specialised facility (e.g. laboratory) or other location (e.g. incursion, field trip).
- Suitable and accessible safety and first aid equipment (e.g. fire blankets, ice packs, eye wash) as appropriate.
- Personal protective equipment must include fully enclosed footwear. Other personal protective equipment will depend on the activity and may include: apron/coat; lab standard eye protection; gloves; and appropriate face protection (e.g. protective face shield).
- Adequate ventilation and sufficient workspace for the planned activity. Access to a fume cupboard is required where inhalation of a product or reactant is a hazard (e.g. allergen, toxic or odoriferous).
- Follow the Electrical Safety Guideline when using electricity.
- Follow the Safety Guide for the Use of Radiation in Schools and manufacturers' instructions when using lasers. Use the lowest power laser product required for the particular purpose. It is expected that in most circumstances only Class 1 and Class 2 laser products should need to be used in schools.
- High voltage (e.g. 50 - 100kV rumkopff/induction coils) and high pressure apparatus (high pressure vacuum) are to be used by competent and experienced staff only.

Web page

Supervision

Risk level

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Hazards and controls

Before the activity

Hazards	Control measures
Considering environmental conditions	• Undertake a reconnaissance of new or infrequently used fieldwork areas to ensure suitability and safety. • When intending to conduct activities outside, assess weather (Bureau of Meteorology) and environmental conditions. Cease activities when conditions tend towards unfavourable (e.g. impending storm). Ensure the school's sun safety strategy is followed.
Accessing facilities and using equipment	• Review experimental procedures. Identify, record and control foreseeable hazards associated with individual activities. • Refer to, and follow, supplier Safety Data Sheets (SDS), manufacturer instructions or product information sheets when using chemicals and equipment. • Equipment must be well-maintained, transported safely, stored appropriately when not in use and cleaned following use. Visually inspect equipment and remove damaged electrical equipment, glassware and/or apparatus from service. • Establish, induct and implement procedures for clean-up and storage of equipment. • Label high risk resources and equipment using the safe operating procedure (SOP) or SDS supplied by the manufacturer. Allow use only by an adult supervisor. • Implement protection and handling processes to avoid accidental contact with chemicals (e.g. labelling of chemicals, rinsing equipment after use). If hazardous chemicals or biological materials are required, use only the smallest quantity that will guarantee the viability of the experiment. • Use electrical leads appropriately. If leads are to cross floors, secure (e.g. tape down) and cover for protection. • Restrict student access to any equipment that requires thermal insulation (e.g. liquid nitrogen, incubator). • Establish, induct and implement procedures for management and disposal of wastes (e.g. disposed in a designated receptacle) and 'sharps' (e.g. broken glassware). Refer to SDS or consult local authorities on the appropriate means of disposal. • Ensure all emergency equipment and processes (e.g. shut-off switches) are functional prior to commencing the activity. • Use (or prepare) standard operating procedures to address all safety aspects of the activity (e.g. use the safe operating procedure (SOP) Performing an eye dissection or a Science-based risk assessment tool). These procedures should address all aspects fo the activity (e.g. appropriate level of facilities for microbial risk groups, handling, disposal and sterilisation procedures). Attach these procedures to this CARA record.

List hazards and control measures

List variations
Eg: Swell height, weather forecast (storms etc)

Include all resources
– transport, equipment etc

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Step 1: List the hazards

- Complicated/unfamilar entry points to study site
- Waves
- Changing weather
- Sun, heat
- Slippery rocks
- Venomous creatures
- Equipment with trip hazards
- Uneven surfaces

Step 2: List the consequences

Step 3: Determine the likelihood

CONSEQUENCES					LIKELIHOOD
Insignificant	Minor	Moderate	Major	Severe	
Medium	High	High	Very High	Very High	Almost certain
Medium	Medium	High	High	Very High	Likely
Low	Medium	High	High	Very High	Possible
Low	Low	Medium	Medium	High	Unlikely
Low	Low	Medium	Medium	Medium	Rare

Bob Moffatt

Step 4: Then list the control measures to reduce the risk to low

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Examples

Hazard – slippery rocks

Consequence - broken arm

Likelihood – high

Control measures

- Training in walking over rocks – teach three points of contact
- Non slip shoes with socks and sides – snorkelling boots are ideal
- Issue instructions

Hazard – dangerous marine creature

Consequence – severe sting or envenomation

Likelihood – high

Control measures

- Issue gloves
- Issue instructions – don’t pick up if unsure – ask, use gloves, don’t wipe eyes after picking up
- Carry first aid kit

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Hazard – waves

Consequence – drowning, being knocked over and rendered unconscious

Likelihood – high

Control measures

- Use an observer and set no go zones
- Issue instructions – don't turn back on waves
- Eliminate the hazard – cancel trip

Hazard – transect square (quadrat)

Consequence – tripping over, hitting head and rendered unconscious

Likelihood – high

Control measures

- Use labels on transect square – danger do not trip
- Issue instructions – don't fall over transect quadrat– use observers in group

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Modern control measures consist of a series of 6 hazard controls:

1. Eliminate the hazard
2. Substitute the hazard with a lesser risk
3. Isolate the hazard
4. Use engineering controls
5. Use administrative controls
6. Use personal protective equipment



Sign of the times

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For example

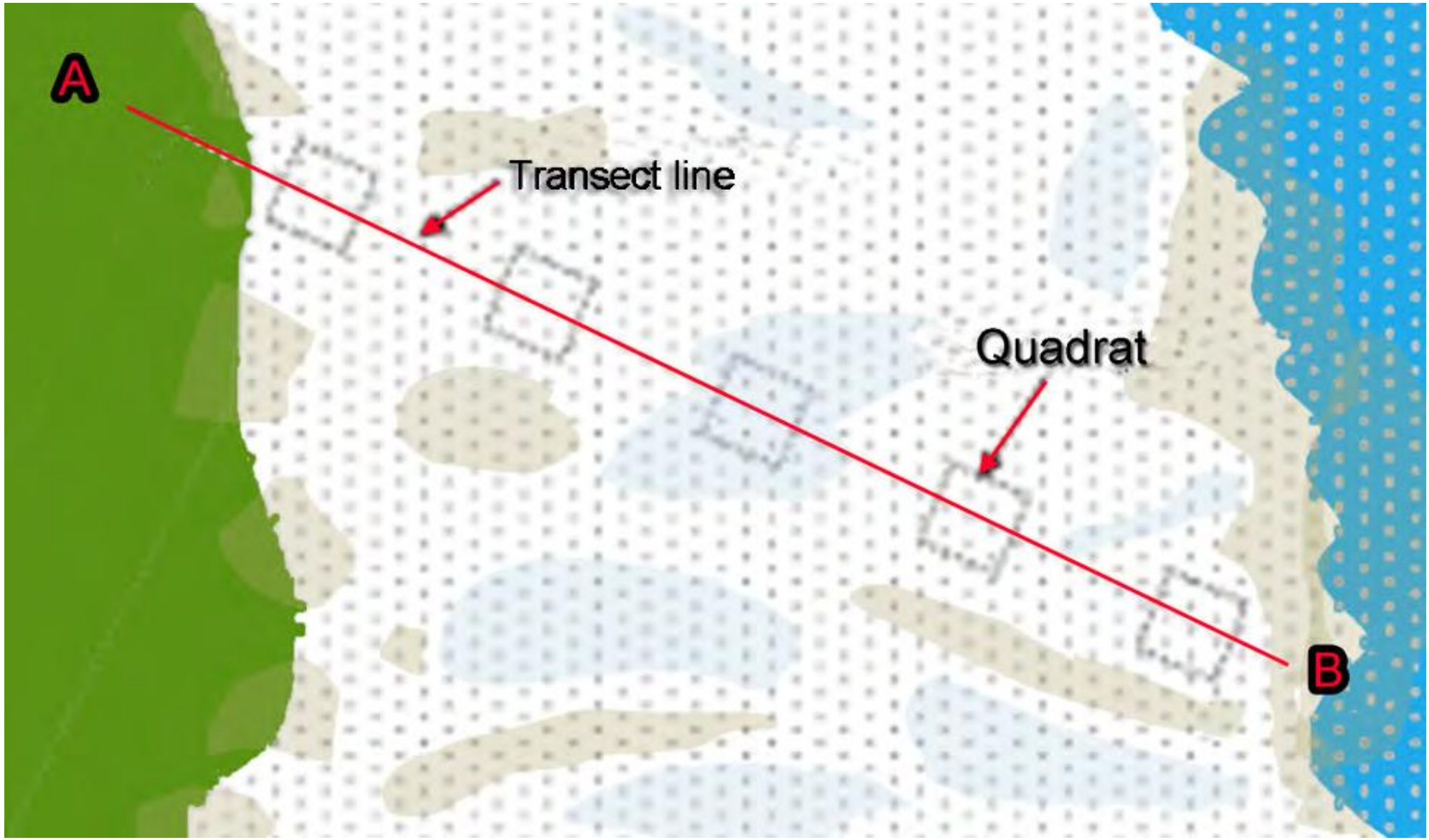
For example, a 25 hp outboard motor is a hazard when carrying it to the boat to mount it on the transom. The following sequence of control measures could be followed:

- Eliminate the hazard. Eg, Do not allow passengers to carry motors.
- Substitute the hazard with a lesser risk. Eg, Use a 15 hp motor.
- Isolate the hazard. Eg, Mount the outboard on the transom permanently.
- Use engineering controls - Eg, Use a small hydraulic lift to position the motor when mounting.
- Use administrative controls - Eg, Issue instructions - two passengers to carry the motor.
- Use personal protective equipment - Eg issue gloves, steel capped shoes, high visibility shirts, protective overalls



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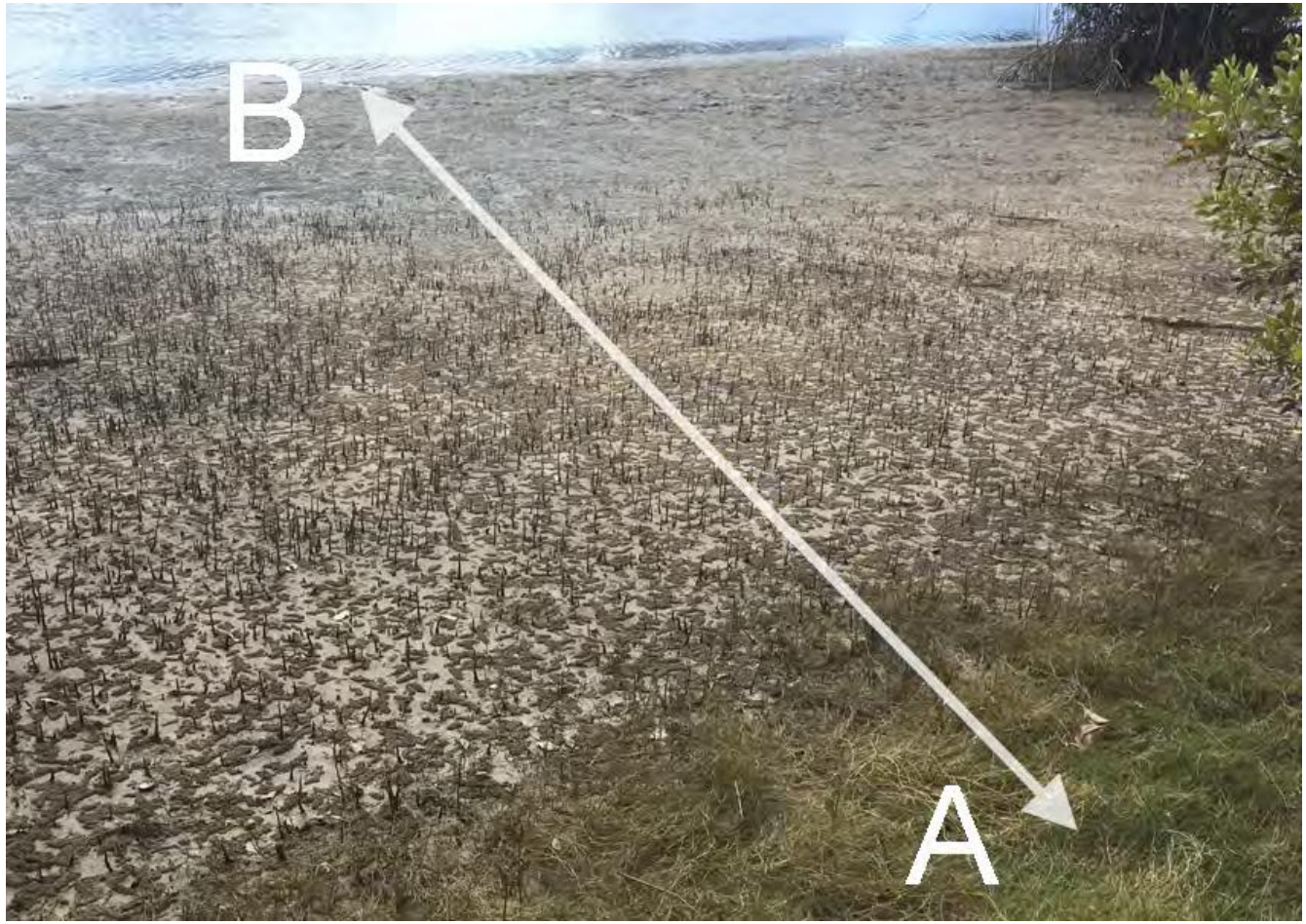
Set up your transect, equipment and safety control measures.



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At the end of the day, if the site proves too difficult to control – substitute the site for another one with fewer hazards (Eg a park with a creek mangrove mudflat at low tide).



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Results

Sample results from sample site 5.

Station No 5

Species present	No counted	Dominance
Limpet	7	Sub Dominant
Periwinkle	35	Dominant
Chiton	1	Present
Algae	80%	Co-dominant
Limpet	7	Sub Dominant

Water temperature	28 ^{o}C
D.oxygen	4 mg/L
Salinity	38 mg/L
Turbidity	4 m
Wave action	Low tide - nil, high tide - exposed
Wind action	Fully exposed
Nitrates	.62 mg/L
Phosphates	.04 mg/L

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Results tabulated

Rocky shore data result sheet
Moffatt Headland
12-May-15
1100 - 1300 hrs

Latitude -29o40'59.99 S
Longitude 153o19'60.00 E

Wind dir	Wind speed	Cloud cover	Air temp
S/E	10km/hr	10%	22oC

Station number	Distance out (m)	Distance down (m)	Description	Temp oC	Salinity g/L	Oxygen mglL	pH 0.0 - 14.0	Phosphates mg/L	Nitrates mg/L	Dominant species	Co dominant species	Sub dominant species
1	0	0	Rocky cliff	22	N/a	N/a	N/a	N/a	N/a	-	-	Seagulls
2	10	-2.5	Very small pool	21	39	5.02	7.6	0.4	10.2	Nodular periwinkle		Microalgae
3	20	-5.8	Exposed rock	23	N/a	N/a	N/a	N/a	N/a	-	Algae and chiton	Nodular and blue grey periwinkle
4	30	-6	Rock pool	18	36	6.13	7.7	0.3	3.4	Chitons	Algae	Crab A and algae
5	40	-7	Rock pool	16	36	6.23	7.6	0.3	3.5	-	-	Algae
6	50	-7.5	Exposed rock	17	N/a	N/a	N/a	N/a	N/a	-	Limpet	Blue grey periwinkle, algae and chiton
7	60	-8	Deeper rock pool	14	34	7.52	7.9	0.1	2.4	-	Limpets, sea stars, anemones, small fish	Crab B
8	70	-9	Wave zone	14	34	7.56	7.9	0.1	2.6	Barnacles	-	
9	>70	-9.5	Wave zone	14	34	7.61	7.9	0.1	2.5	Kelp	-	

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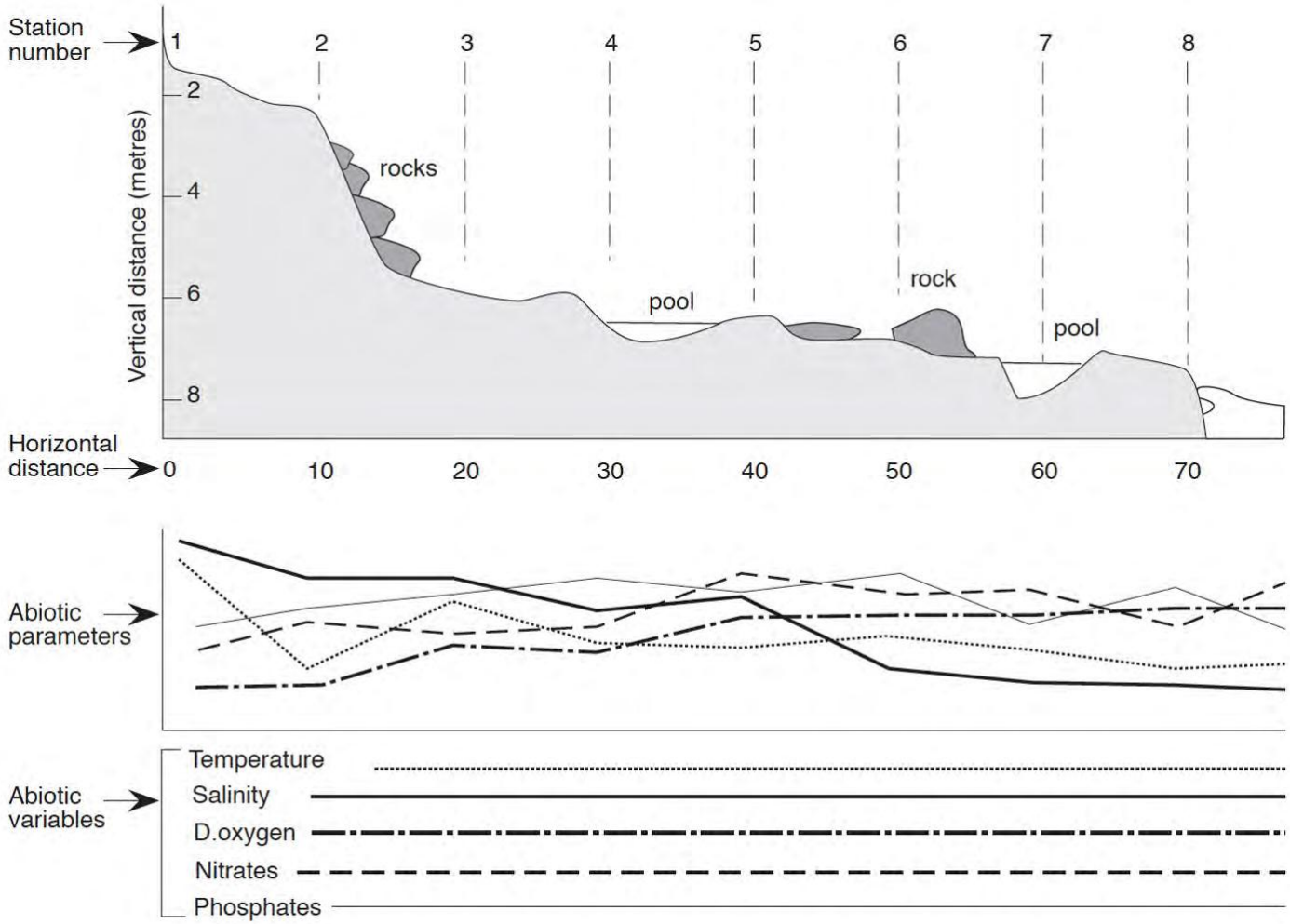
Results shore profile

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
1	Rocky shore data result sheet														
2	Moffatt Headland														
3	12-May-15														
4	1100 - 1300 hrs														
5															
6	Latitude	-29o40'59.99 S													
7	Longitude	153o19'60.00 E													
8															
9	Wind dir	Wind speed	Cloud cover	Air temp											
10	S/E	10km/hr	10%	22oC											
11															
12	Station	Distance	Distance	Description	Temp	Salinity	Oxygen	pH	Phosphates	Nitrates	Dominant	Co dominant	Sub dominant		
13	number	out (m)	down (m)		oC	g/L	mgIL	0.0 - 14.0	mg/L	mg/L	species	species	species		
14	1	0	0	Rocky cliff	22	N/a	N/a	N/a	N/a	N/a	-	-	Seagulls		
15	2	10	-2.5	Very small pool	21	39	5.02	7.6	0.4	10.2	Nodular periwinkle		Microalgae		
16	3	20	-5.8	Exposed rock	23	N/a	N/a	N/a	N/a	N/a	-	Algae and chiton	Nodular and blue grey periwinkle		
17	4	30	-6	Rock pool	18	36	6.13	7.7	0.3	3.4	Chitons	Algae	Crab A and algae		
18	5	40	-7	Rock pool	16	36	6.23	7.6	0.3	3.5	-	-	Algae		
19	6	50	-7.5	Exposed rock	17	N/a	N/a	N/a	N/a	N/a	-	Limpet	Blue grey periwinkle, algae and chiton		
20	7	60	-8	Deeper rock pool	14	34	7.52	7.9	0.1	2.4	-	Limpets, sea stars, anemones, small fish	Crab B		
21	8	70	-9	Wave zone	14	34	7.56	7.9	0.1	2.6	Barnacles	-			
22	9	>70	-9.5	Wave zone	14	34	7.61	7.9	0.1	2.5	Kelp	-			
23															
24	Distance out	Height down													
25	0	0													
26	5	-2													
27	10	-2.5													
28	15	-4													
29	20	-5.8													
30	25	-5.2													
31	30	-6													
32	35	-6.5													
33	40	-7													
34	45	-6.5													
35	50	-7.5													
36	55	-7.4													
37	60	-8													
38	65	-8.5													
39	70	-9.5													
40															
41															
42															
43															
44															



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Results shore abiotic data graphed



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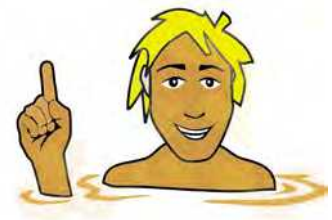
Biotic data analysed



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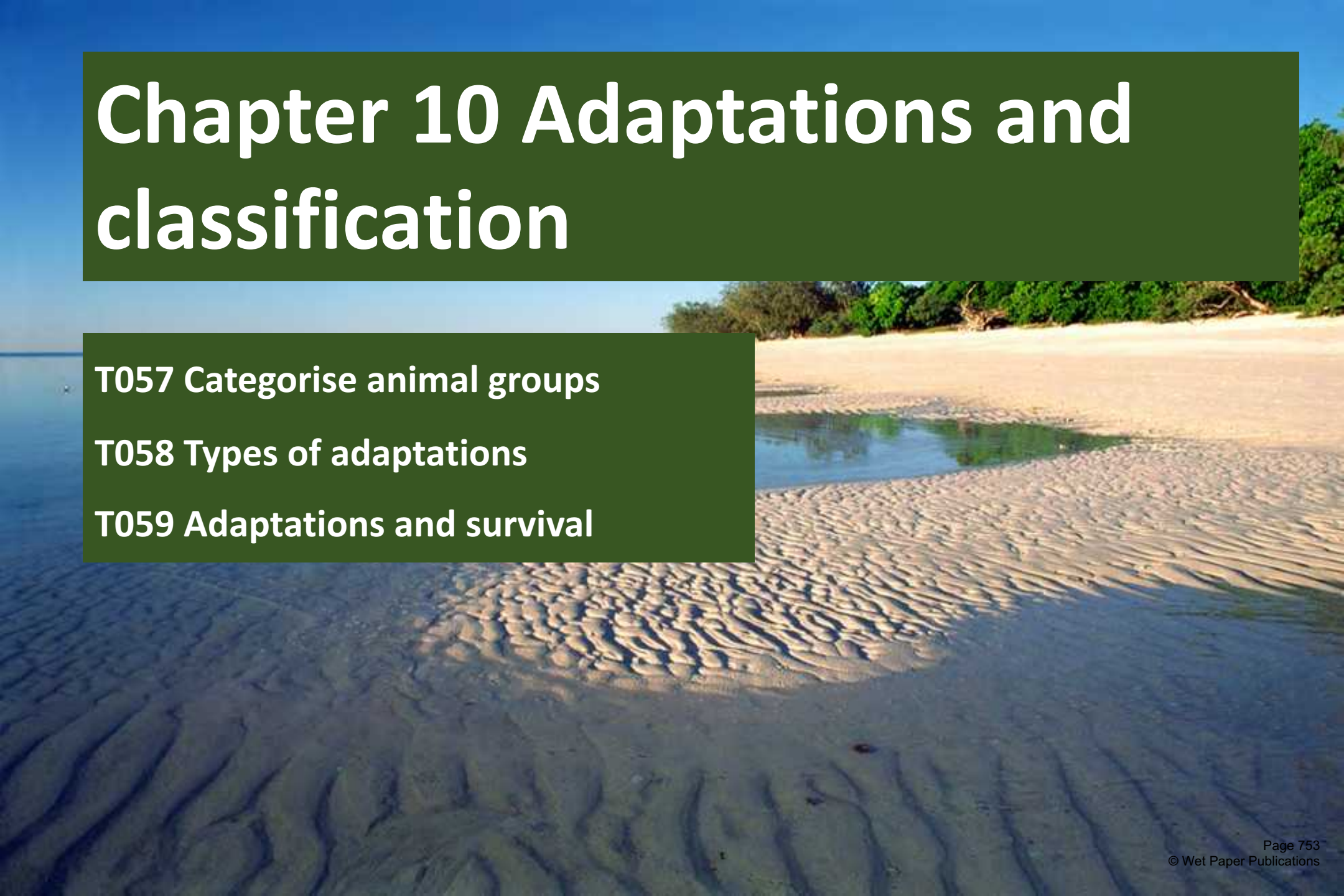
Report

Your teacher will show you the type of report required.



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Chapter 10 Adaptations and classification



T057 Categorise animal groups

T058 Types of adaptations

T059 Adaptations and survival

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T057 Categorise animal groups



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Syllabus statement

At the end of this topic you should be able to ...

categorise

different groups of animals using structural characteristics.





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Categorise

- place in or assign to a particular class or group;
- arrange or order by classes or categories;
- classify, sort out, sort, separate.





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The syllabus and classification

The syllabus does not require a detailed knowledge of classification, so the simplest interpretation the author can give is as follows.



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Structural characteristics

These are characteristic features of an animal that can be used to classify it into a group.

For example, body covering and skeleton type are often used when grouping vertebrate animals.

The body covering in vertebrates has either

- hair, fur, fins, feathers or scales

and the skeleton has either

- bone or cartilage.



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Question

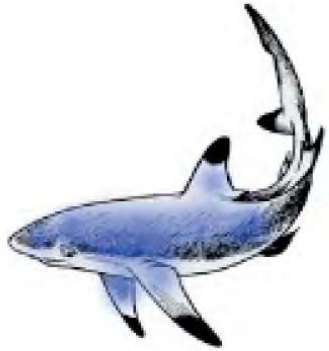
Classify these animals into class groups using the following information.

1.a	The body has feathers	Class Aves
1.b	Feathers not present	go to 2
2.a	Body has hair or fur	Class Mammalia
2.b	Body has no hair or fur	go to 3
3.a	Body has fins	go to 4
3.b	Body has no fins	go to 5
4.a	Skeleton of bone	Class Osteichthyes
4b.	Skeleton of cartilage	Class Chondrichthyes
5.a	Body has scales	Class Reptilia
5.b	Body has no scales	Class Amphibia

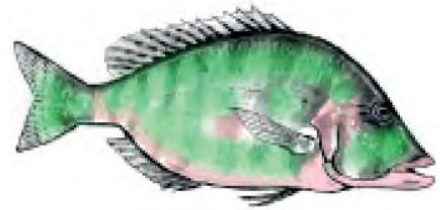


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Answer



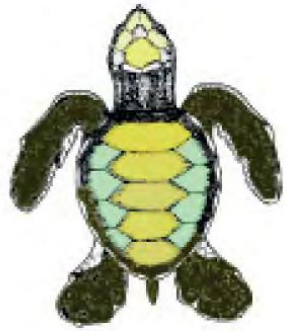
Class Chondrihthyes
(Illustration Rose Bedford)



Class Osteichthyes
(Illustration Kerry Kitzelman)



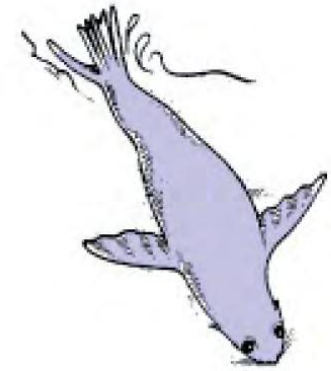
Class Amphibia
(Illustration Clip Art Explosion)



Class Reptilia
(Illustration Steven Byers)



Class Aves
(Illustration Steven Byers)



Class Mammalia
(Illustration Sharyn Madder)

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If you want to know more, you can read a whole series of chapters in *Marine Science for Australian Students*
Chapters 8 – 14.

However the pages that follow may help you when you go to University and actually have to learn about the classification of marine animals and plants like the marine scientists from the olden days.

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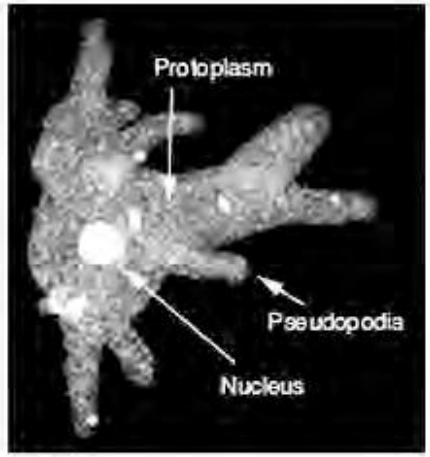
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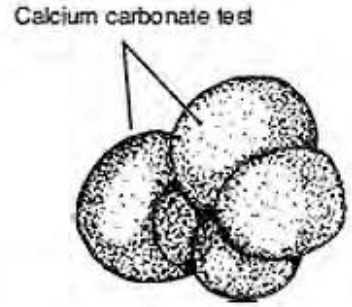
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Phylum Protozoa

Microscopic, single-celled animals.

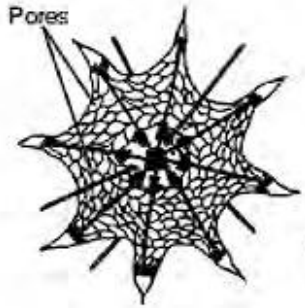


Amoeba





Globigerina



Radiolarian

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T058 Types of adaptations



Bob Moffatt

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Syllabus statement

At the end of this topic you should be able to ...

identify ★

and

classify ★★

adaptations as

- anatomical (structural),
- physiological (functional) or
- behavioural



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Identify

- Locate, recognise and name;
- establish or indicate who or what someone or something is;
- provide an answer from a number of possibilities;
- recognise and state a distinguishing factor or feature

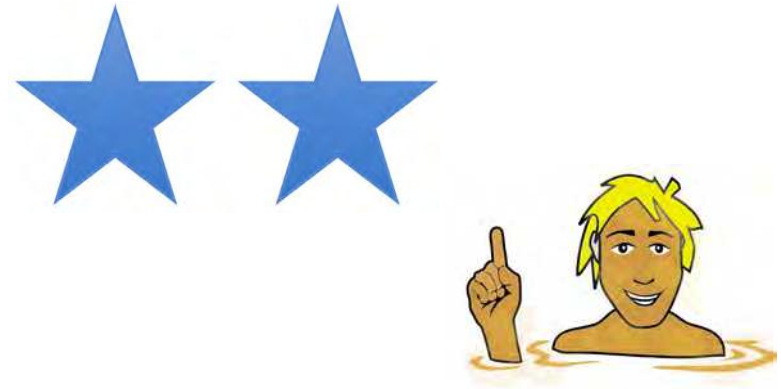




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Classify

arrange, distribute or order in classes or categories
according to shared qualities or characteristics



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Objective

Identify and classify structural, functional and behavioural adaptations in a table using as criteria

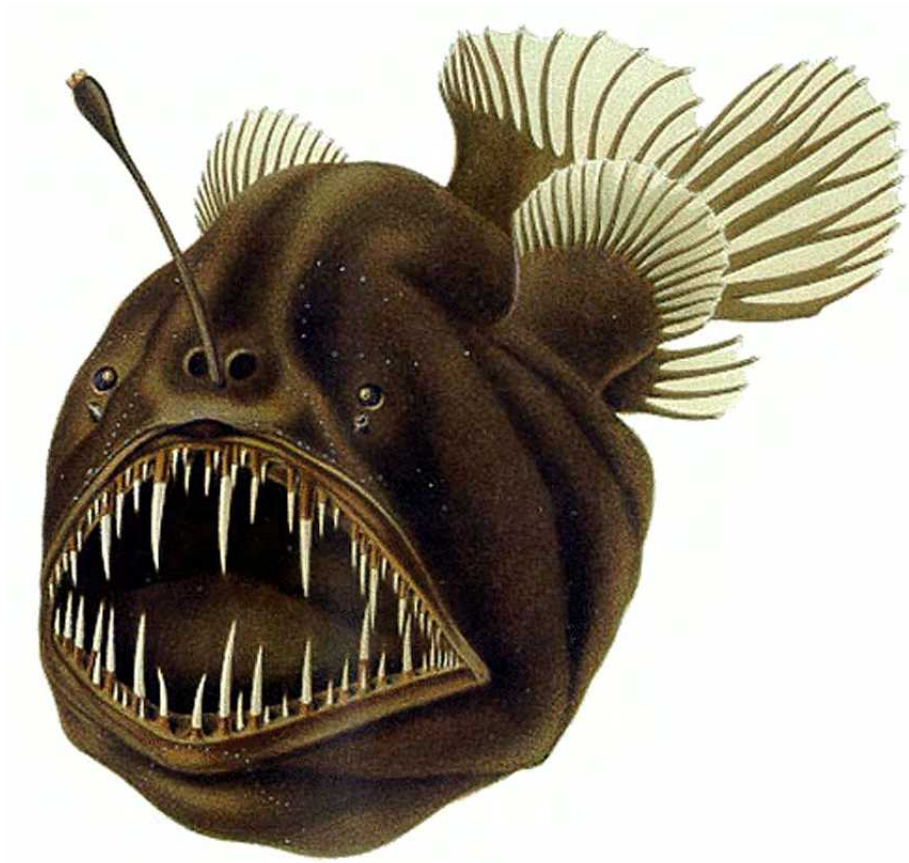
- External body covering,
- Physiology and
- Responses to situations or stimuli

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An adaptation is a characteristic that helps an organism survive.

These types of adaptations include:

- structural (body form),
- functional (physiological), and
- behavioural (response to situations or stimuli)



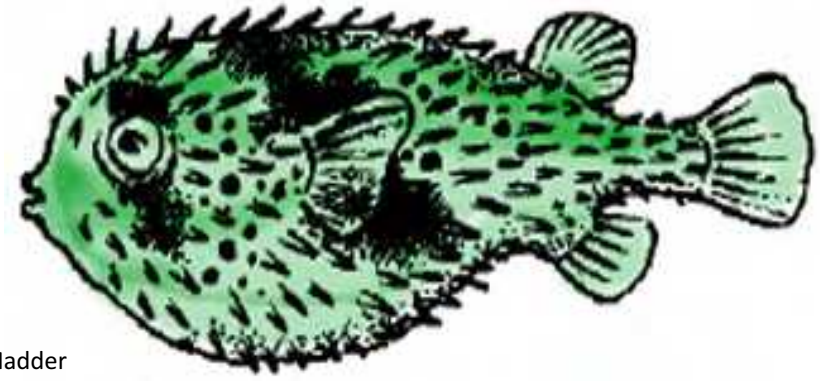
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https://commons.wikimedia.org/w/index.php?curid=54328

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For example, the porcupine fish has:

- spines (a **structural adaptation**),
- toxins in the skin which make you sick (**physiological adaptation**) and
- blows itself up to look much bigger than it really is (a **behavioural adaptation**).



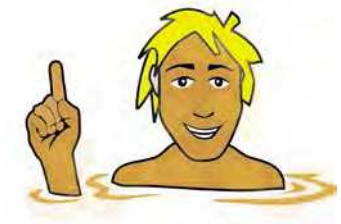


Mike Sudgen and Sharyn Madder

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1. Structural adaptations

- Body cover
- Shape
- Camouflage
- Skeleton type
- Appendages
- Mouth parts



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Body cover – Exoskeleton, armour, scales and spines

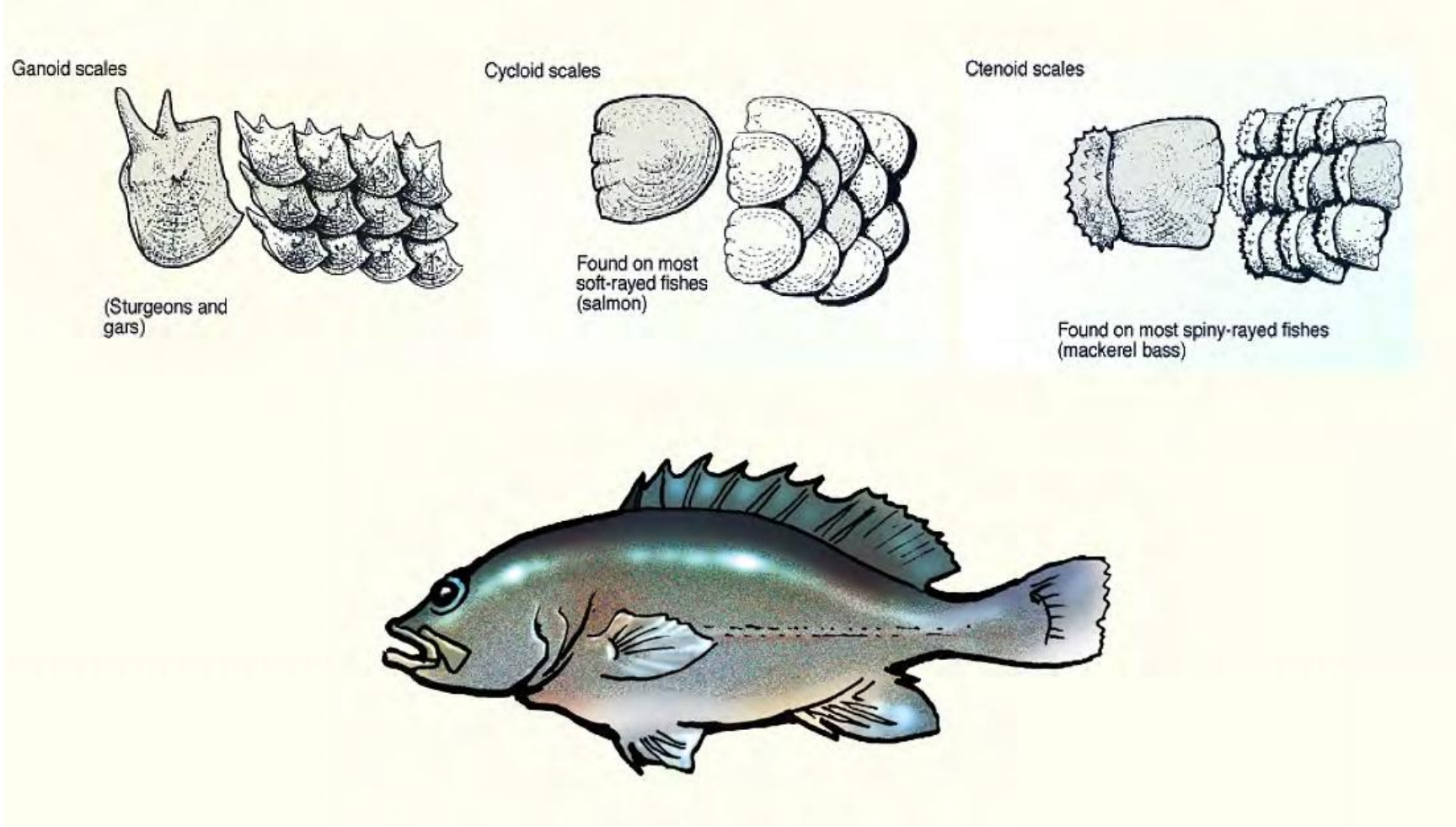
Some animals that have an exoskeleton to protect their soft bodies from predators are barnacles, lobsters, crabs, scallops, clams and oysters.



By Bart Braun - Own work, Public Domain, https://commons.wikimedia.org/w/index.php?curid=4425087

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Fish have scales which act as thin armour.



Bob Moffatt Kerry Kitzelman

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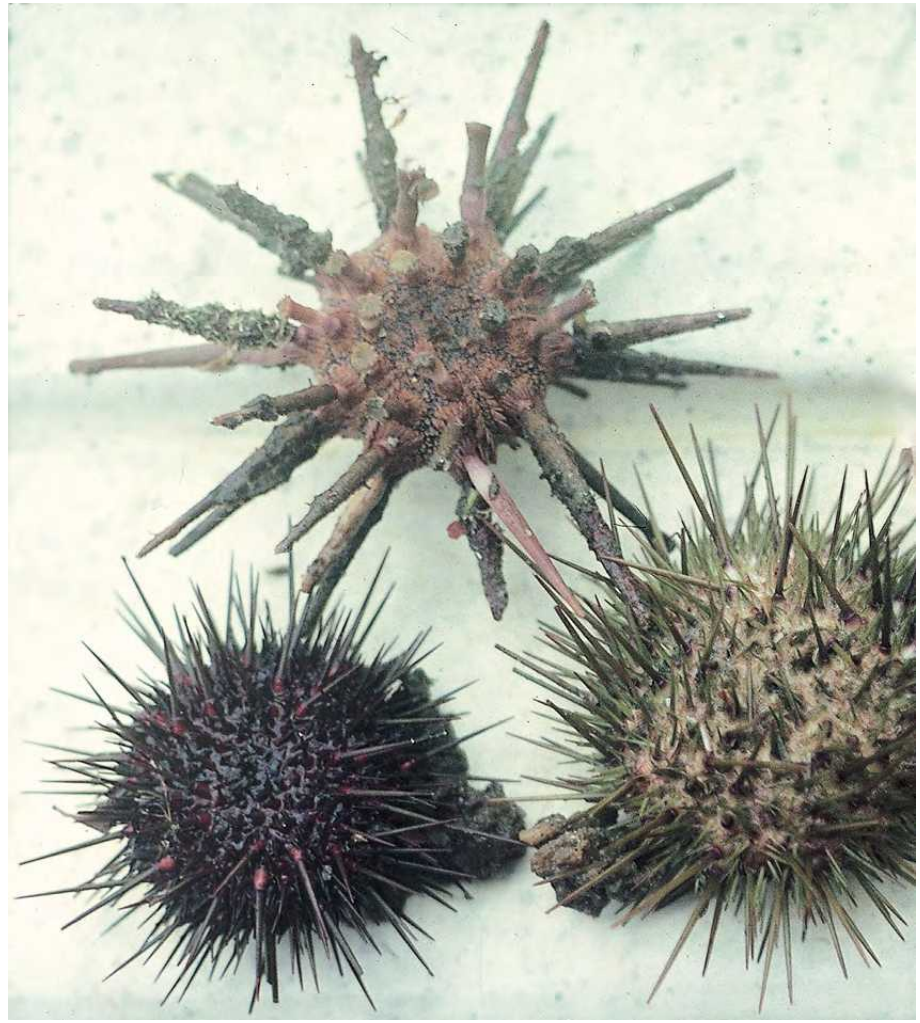
Most animals that develop heavy armour are slow moving eg turtles.



Neville Coleman

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Some animals have developed spines which make them harder to swallow or harder to pull from caves or holes eg sea urchins.



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Oyster shells seal the soft bodied animal in, to stop predation and drying out when exposed to air.

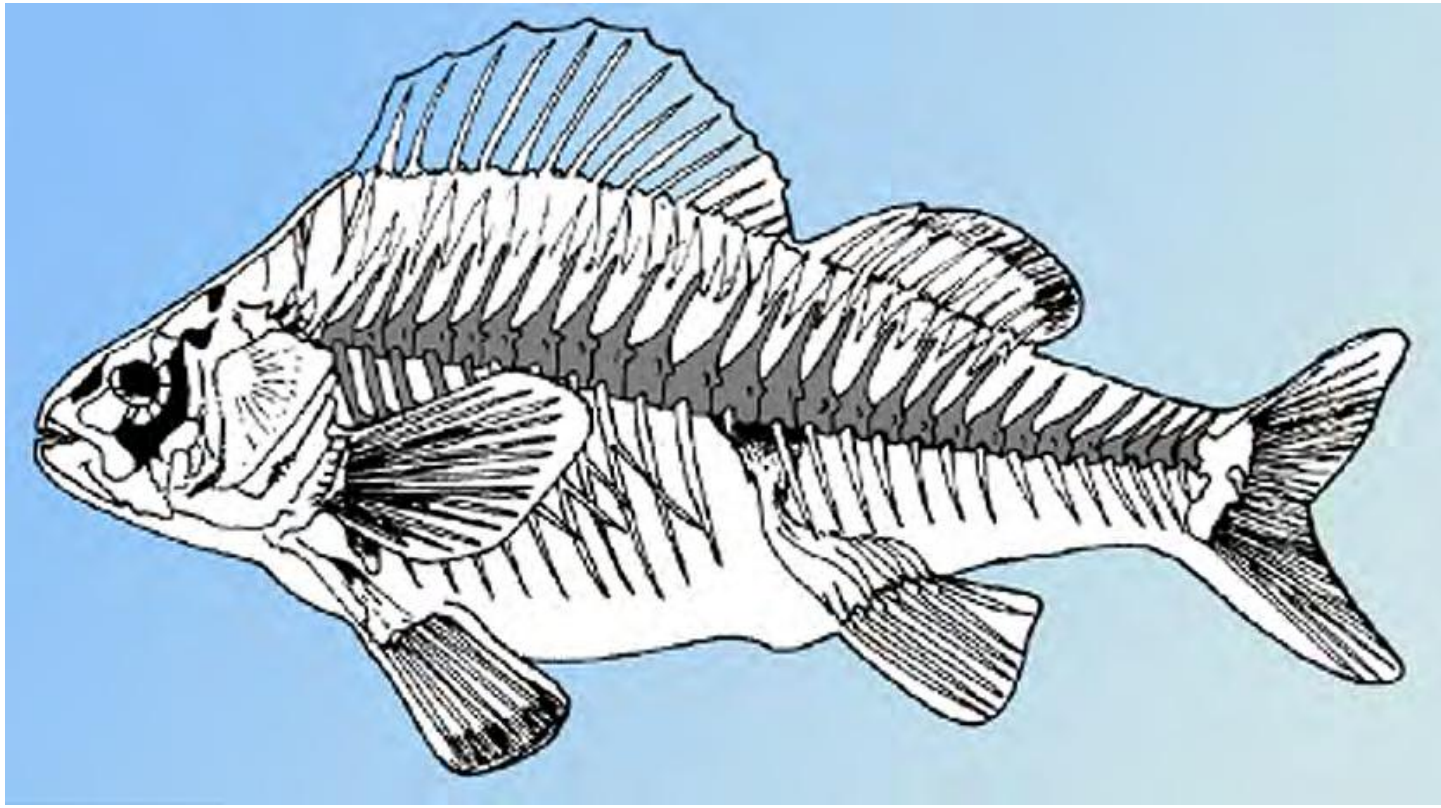


Bob Moffatt

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Internal skeleton

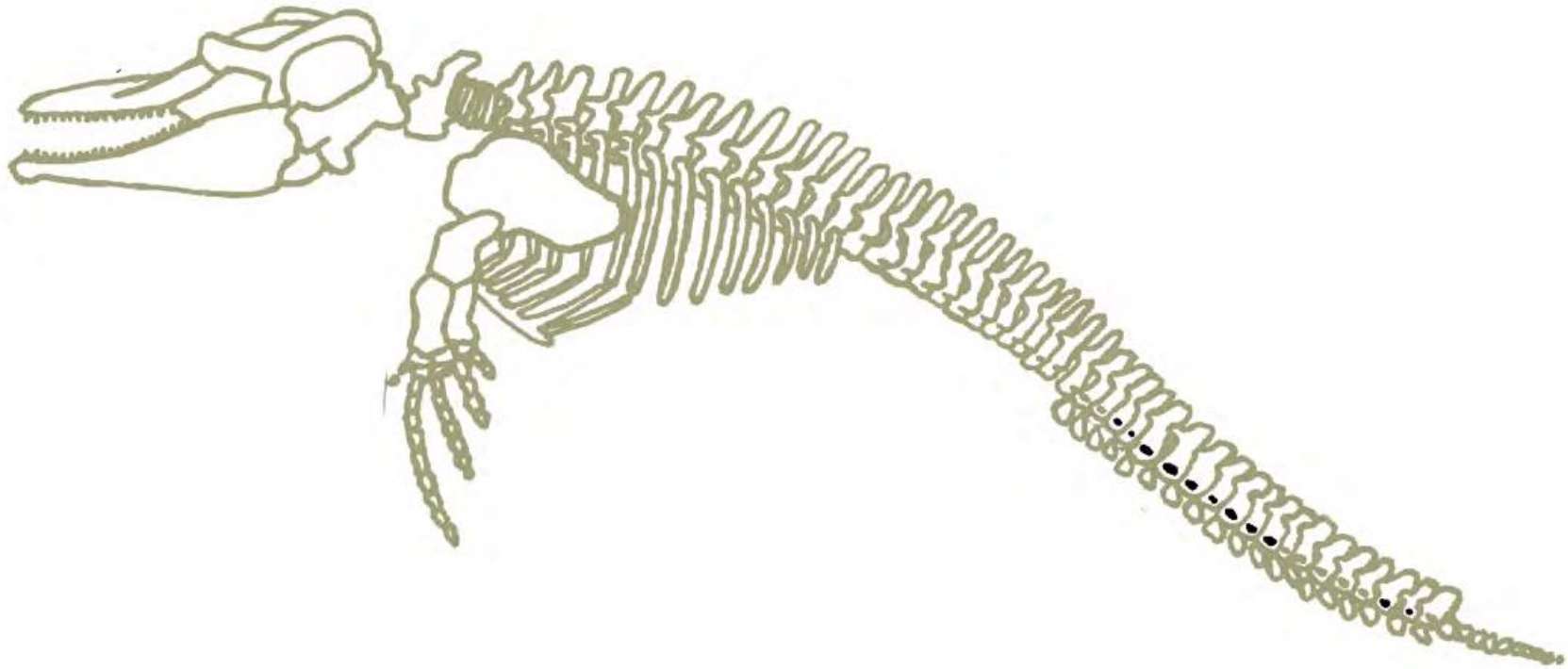
Fish have light flexible bones for swimming.



Brady Moffatt

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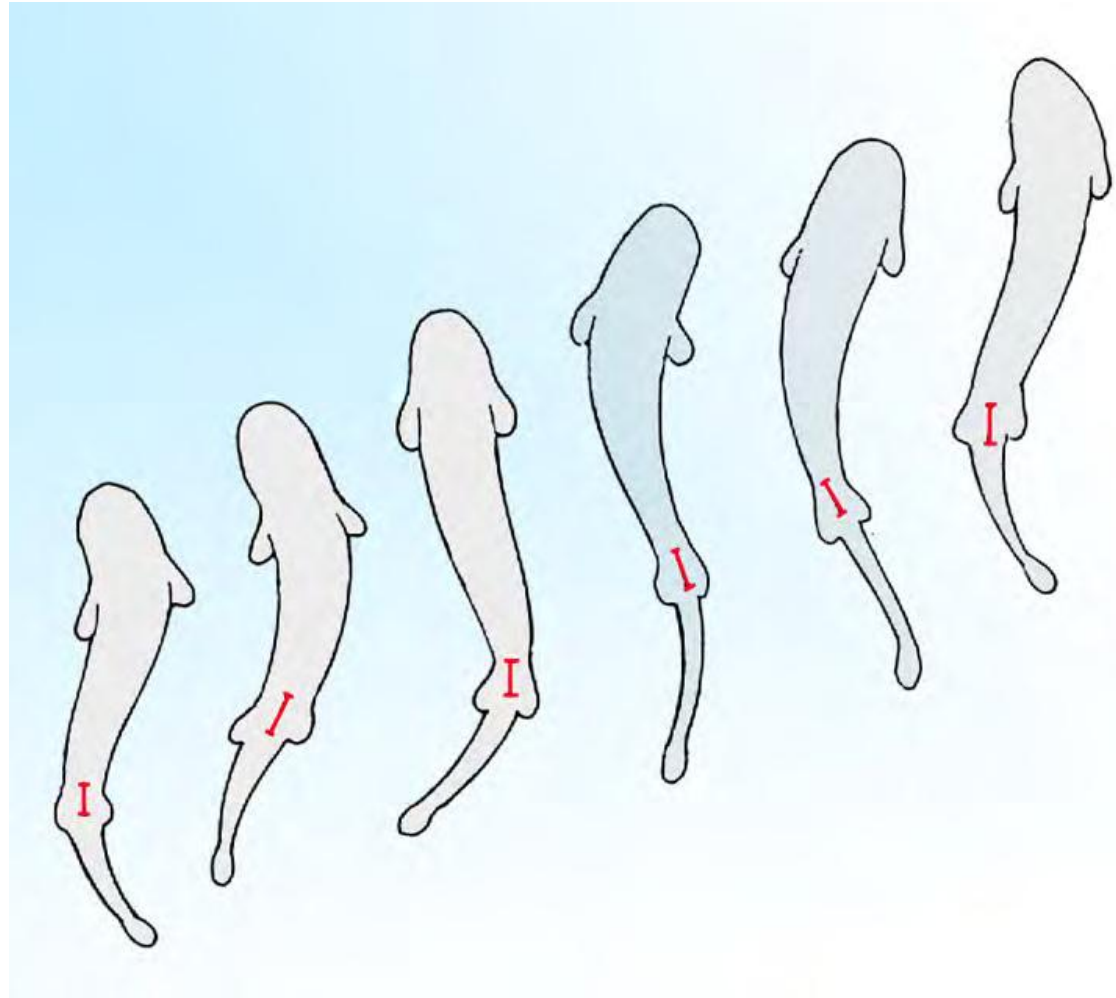
The skeleton extends the entire length of the animal as well as to the fins and tail.



Brady Moffatt

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This allows for an intricate muscular system for precise movement and speed.

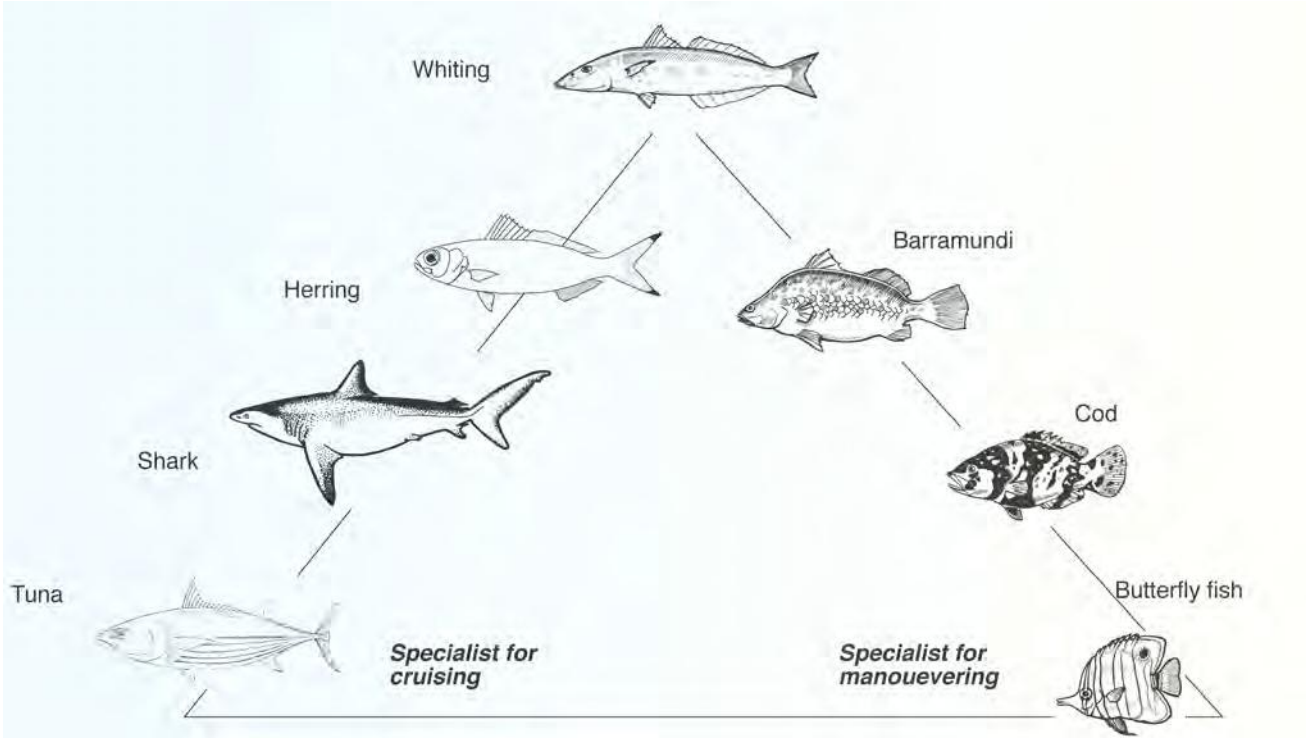


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Body shape

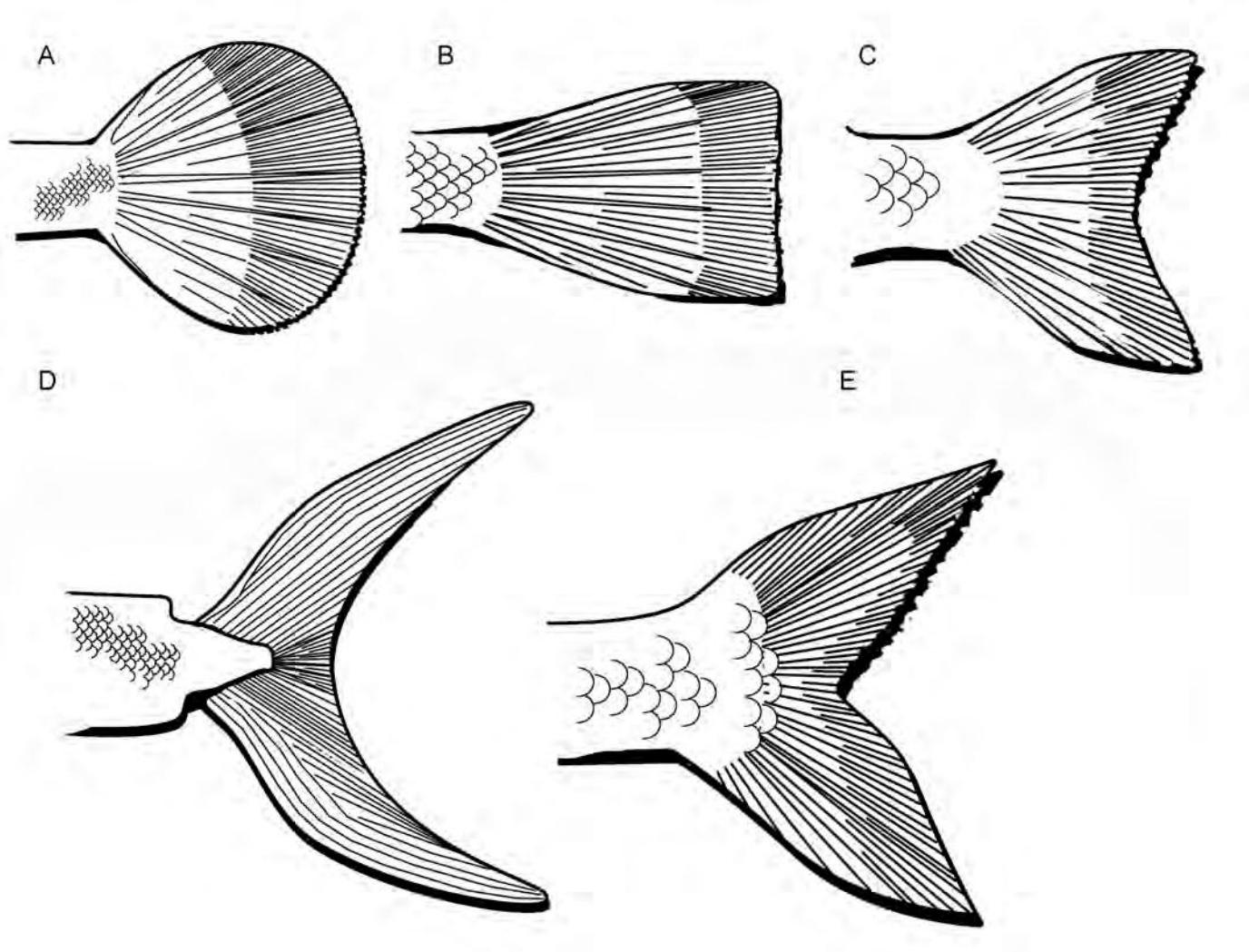
Fish that swim quickly through the water need to be streamlined, have pointed tails and strong muscles. eg Tuna Whereas fish that need to manoeuvre have different shapes.



David Tulip

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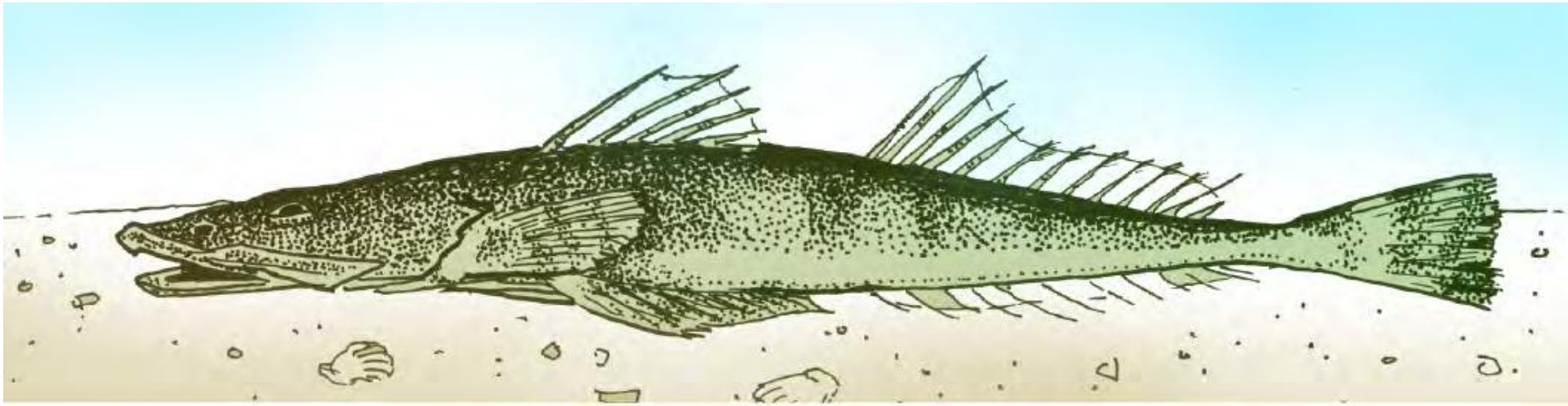
So where do you think these fish live?



Bob Moffatt

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Fish that occupy the benthos need to be flat eg rays, flathead and flounder.





Bob Moffatt Kerry Kitzelman

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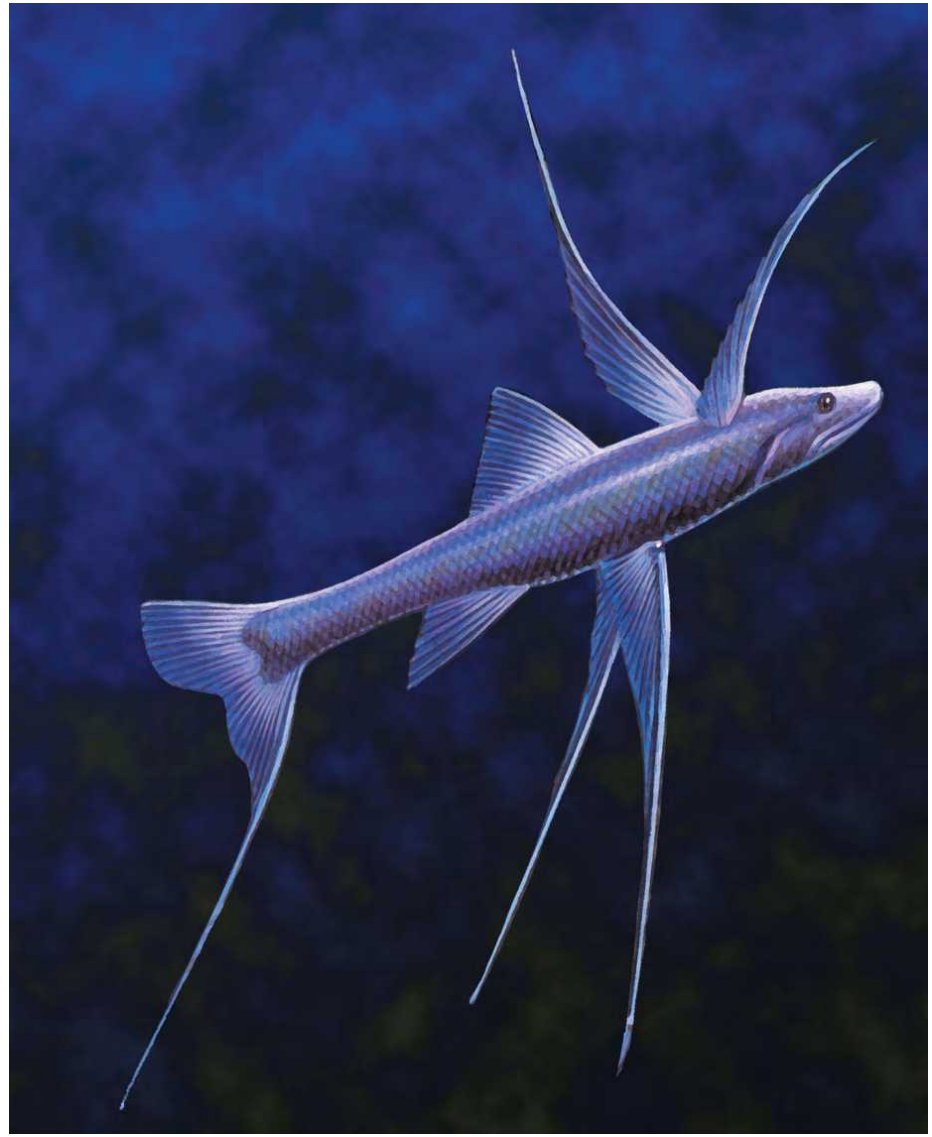
Fish that need to hide in seagrasses have projections from their body eg the leafy sea dragon has projections that look like leaves and the trigger fish has a hook to hold on while it remains motionless.



Neville Coleman

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Deep sea animals have long legs to lift them off the muddy substrate or a foot to slide or burrow through it.



© Wet Paper Publications

A barnacle's round shape disperses waves.





Bob Moffatt

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Camouflage

To escape the detection of the predators, prey may try to match its colour or shape with that of its background.



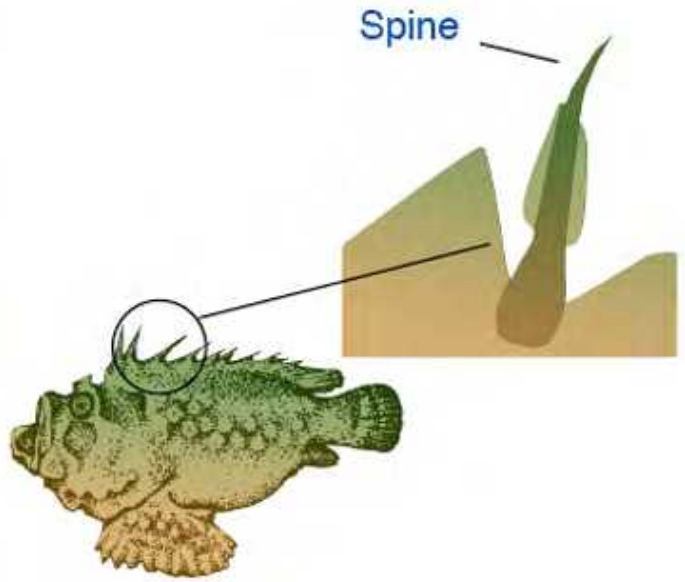
Kerry Kitzelman

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Stonefish are masters of the art of protective concealment.

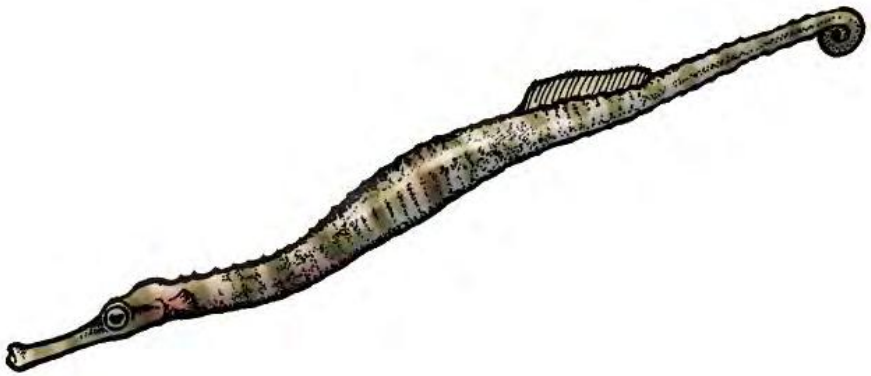


Neville Coleman, Steven Byers and Bob Moffatt



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A sea horse looks like a type of sargassum weed. The pipefish, which live among the eelgrass, look like stalks of the eelgrass. They remain floating vertically, imitating the eelgrass.



Kerry Kitzelman

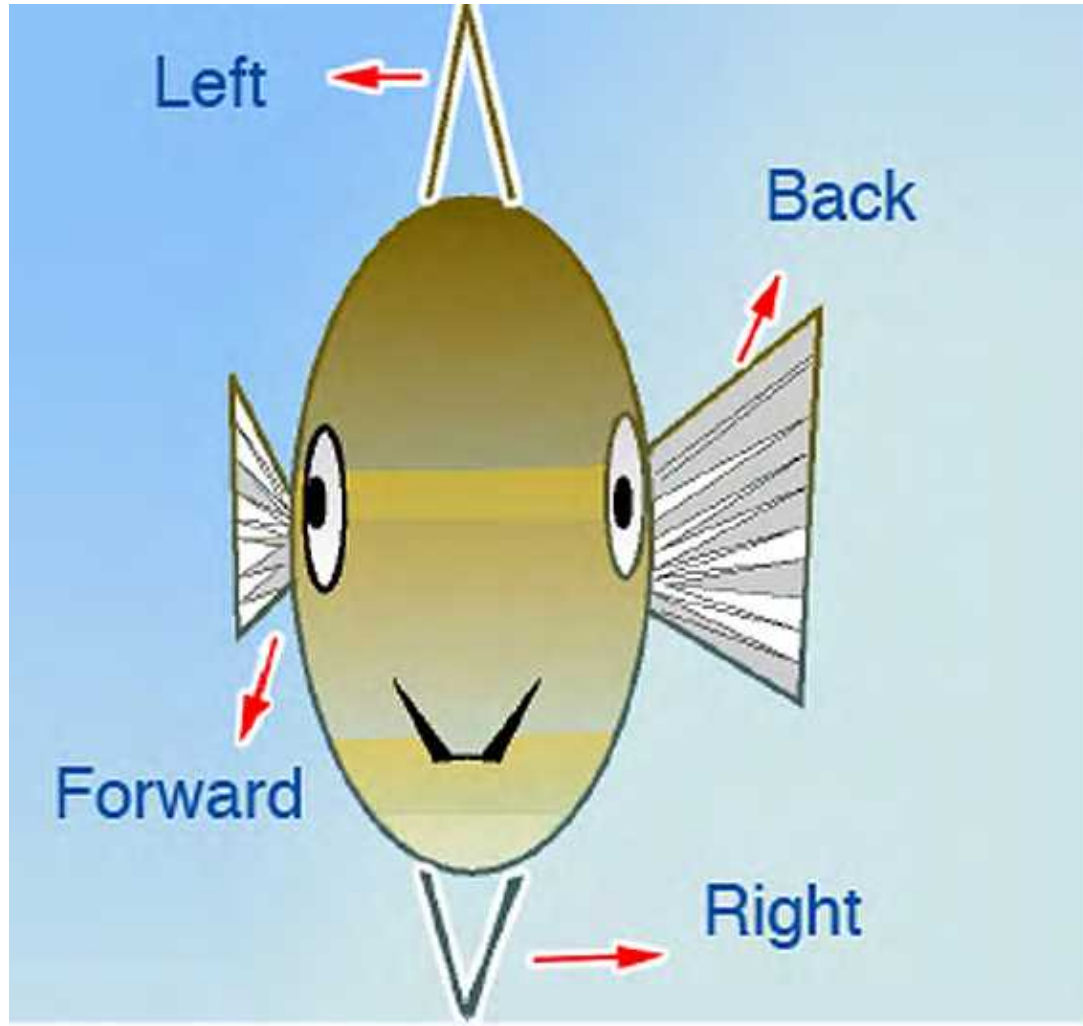


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Appendages

Fins can be used for balance, steering or moving forward or back.

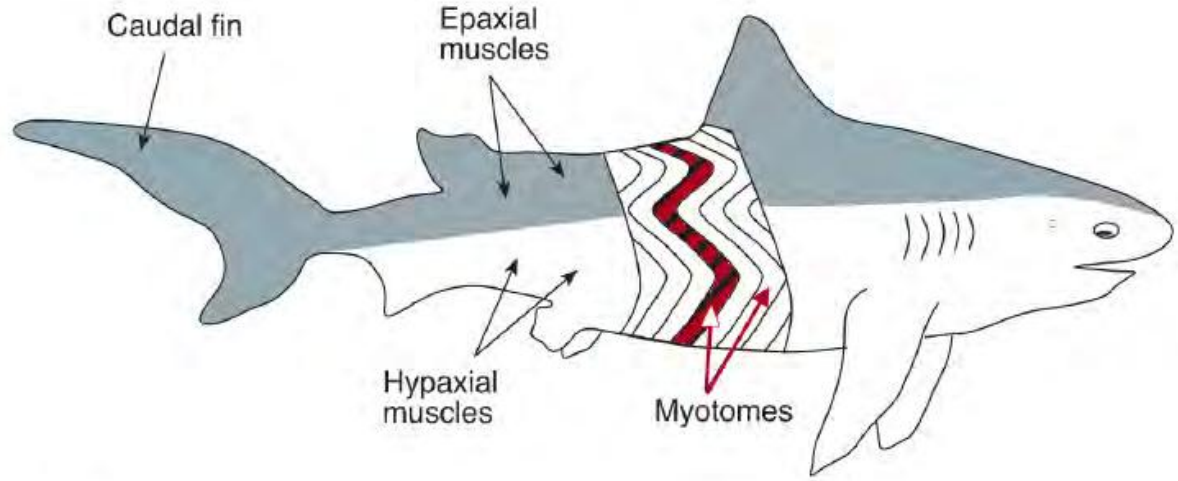


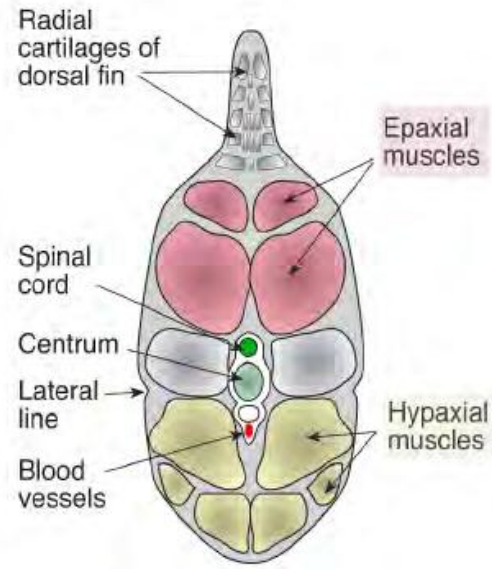
Bob Moffatt

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The great white shark is an excellent example of grace and speed.

The enormous muscles in the abdomen drive the shark forward and with minute deviations of the fins, the shark can hone in on its prey with great accuracy.

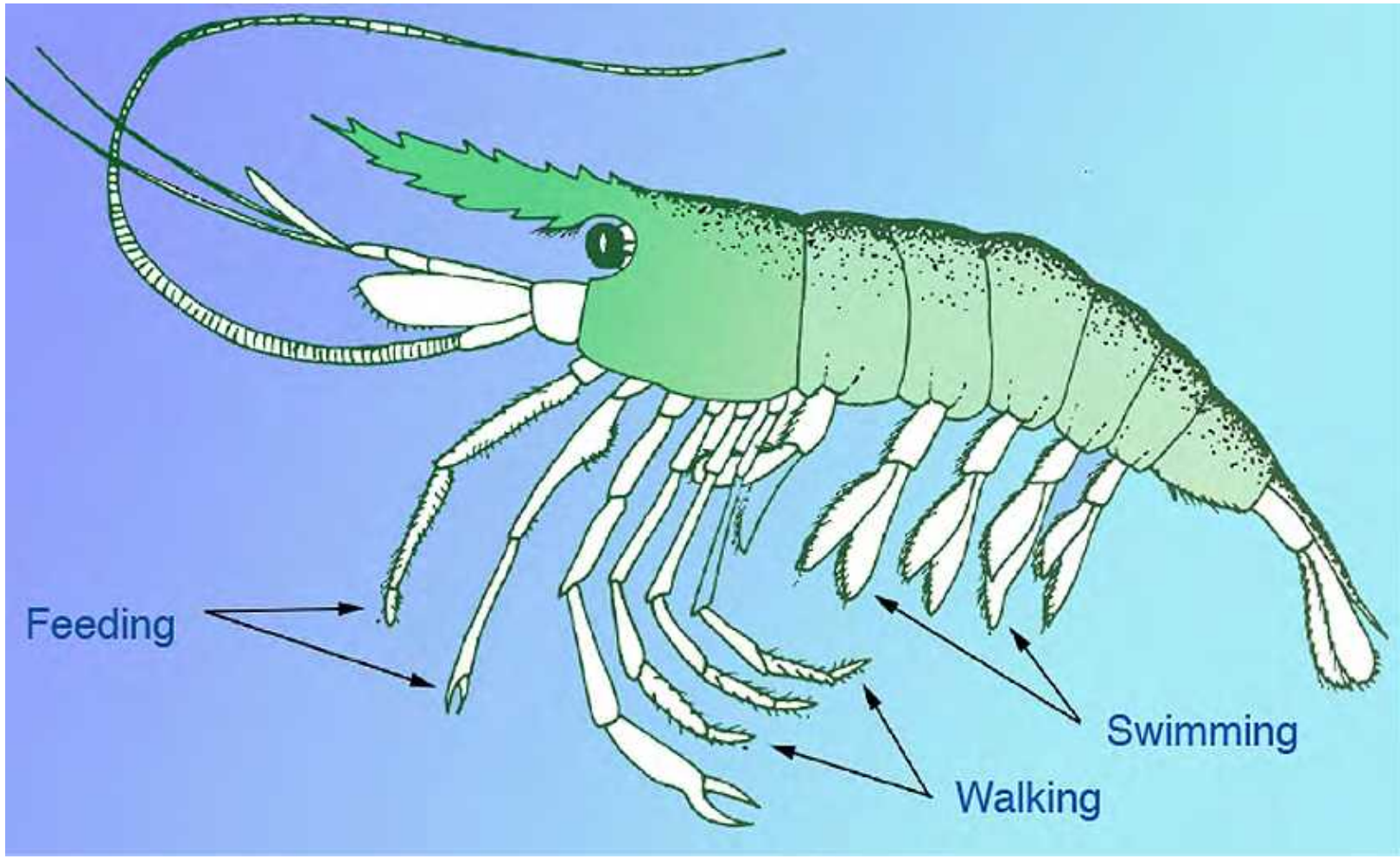




Bob Moffatt

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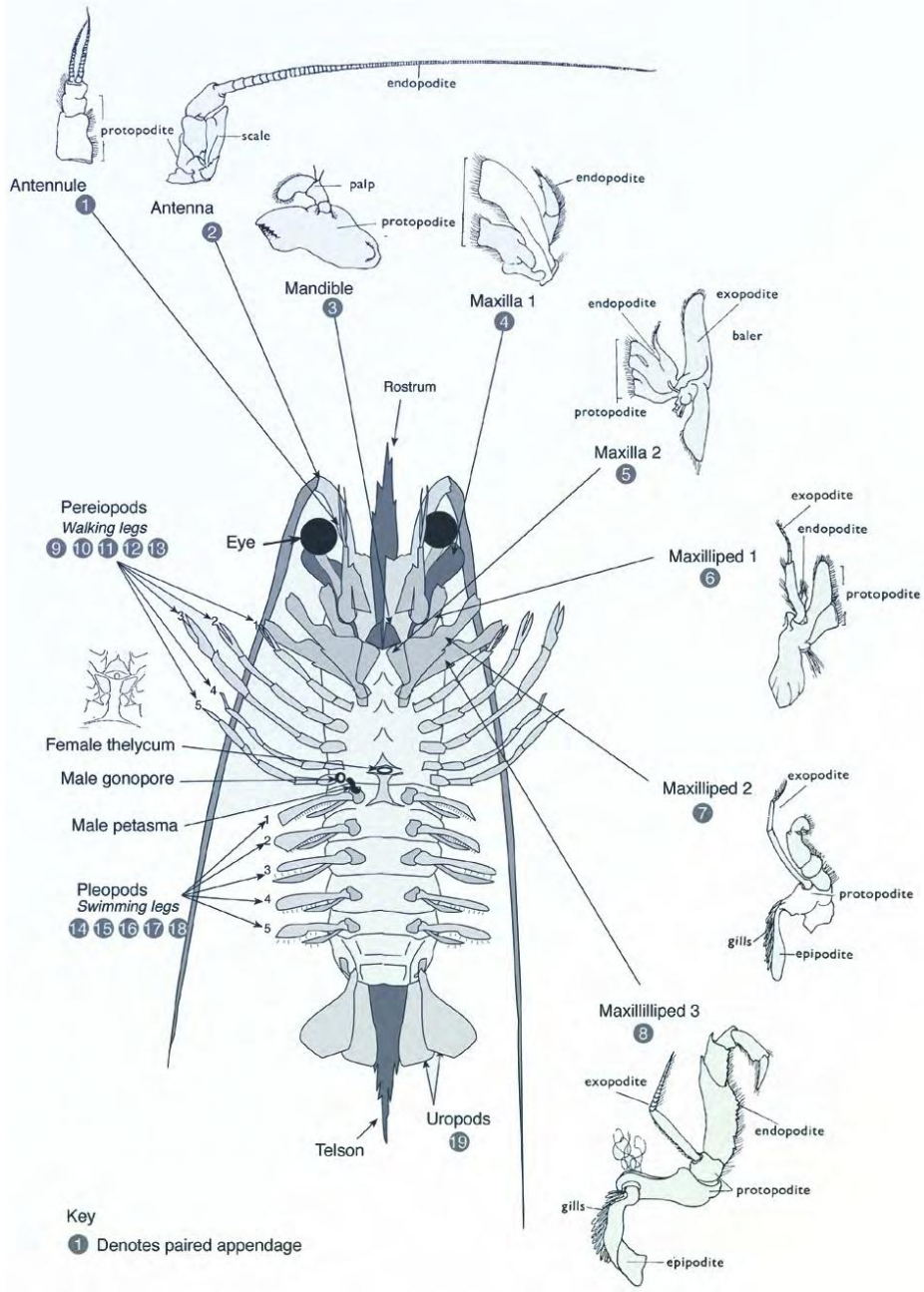
Prawn appendages are examples of adaptations to a benthic life style.



Bob Moffatt

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The claws grab the food and take it to the mouth parts. The walking legs enable the prawn to move around the bottom and the swimming legs propel the animal forward.



Bob Moffatt

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Crab legs allow it to hang on a rocky shore.

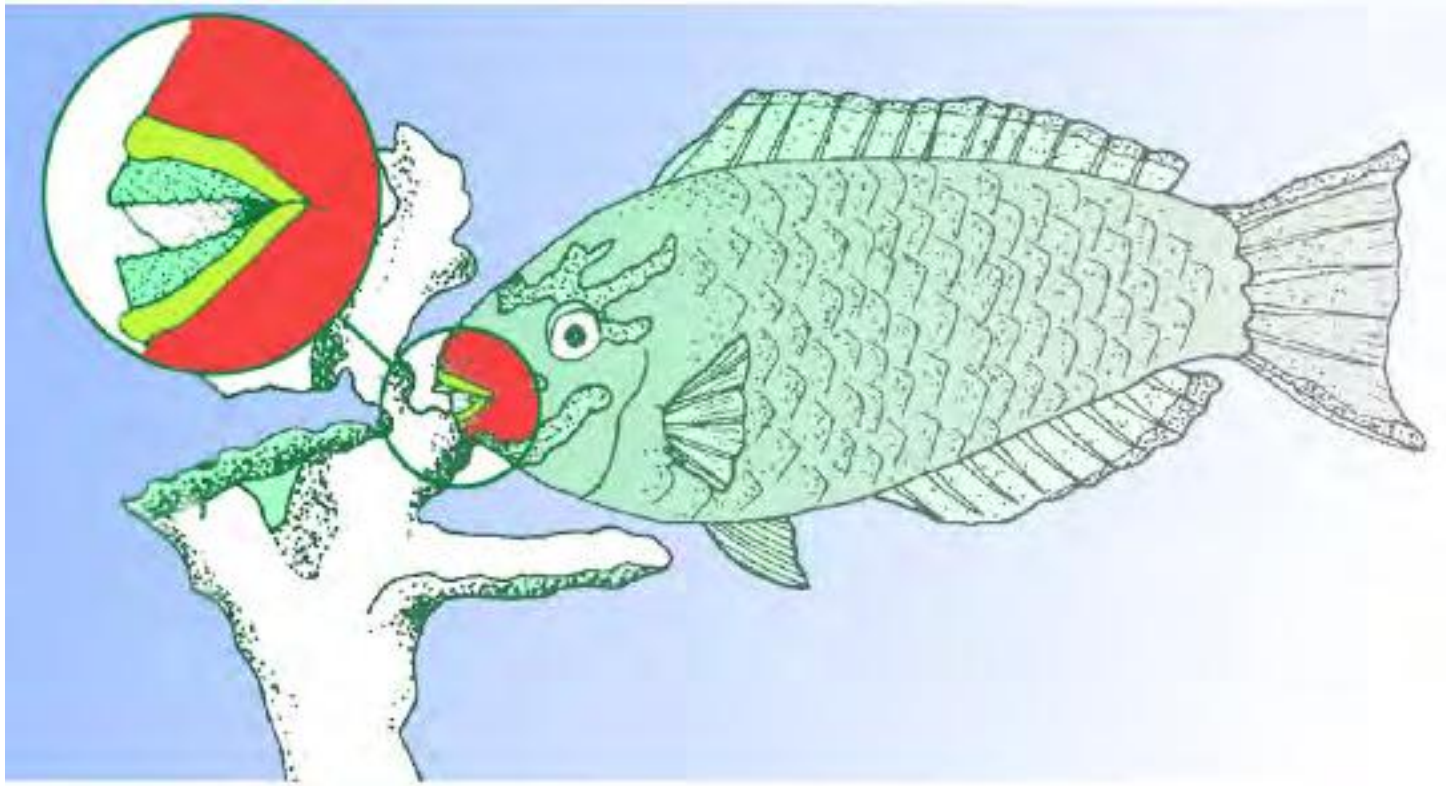


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Mouth parts

Jaws and teeth indicate what fish can feed on.
The parrot fish feeds by biting at its prey so has tusk-like teeth.



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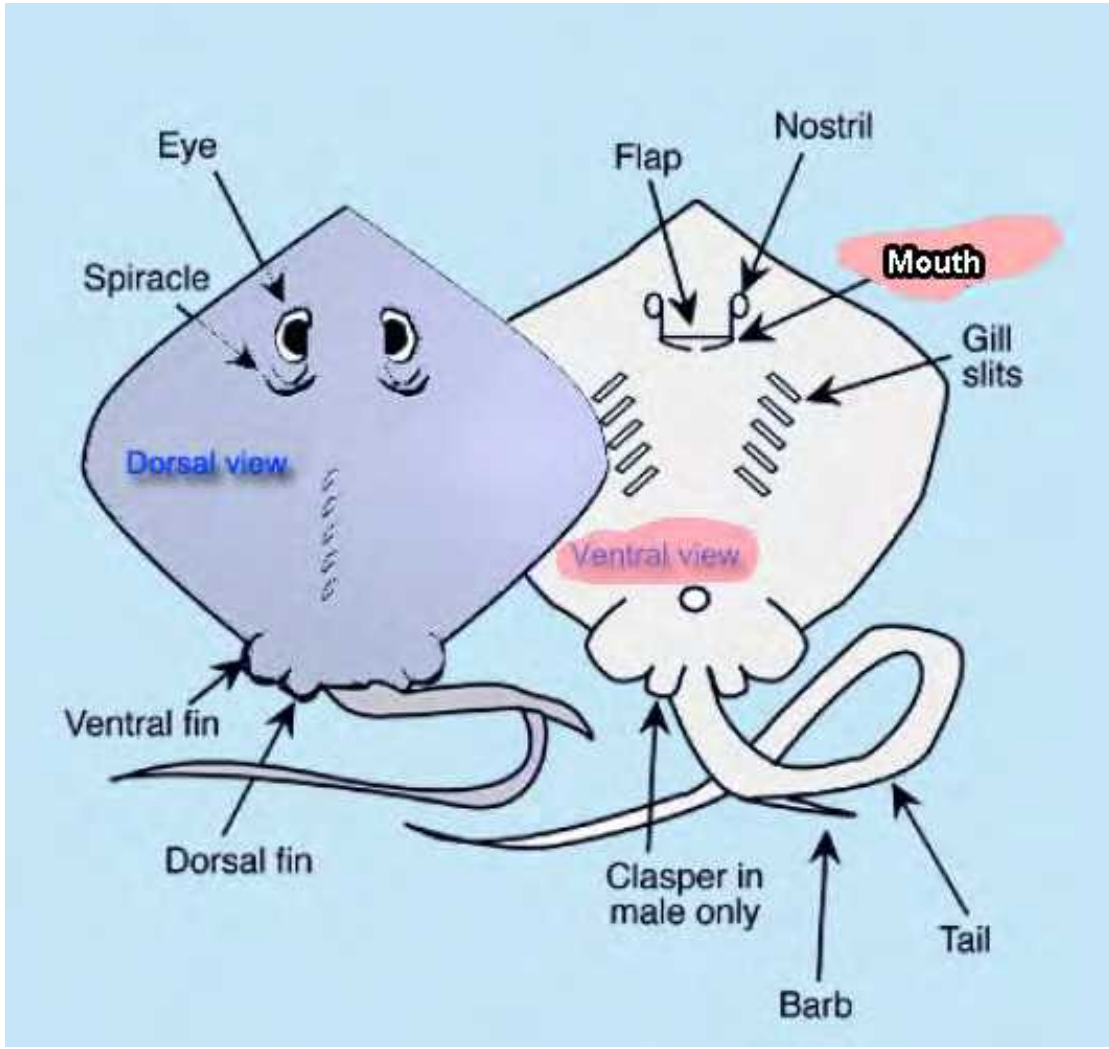
Butterfly fish have long elongated mouths so it can eat from hard to get places.



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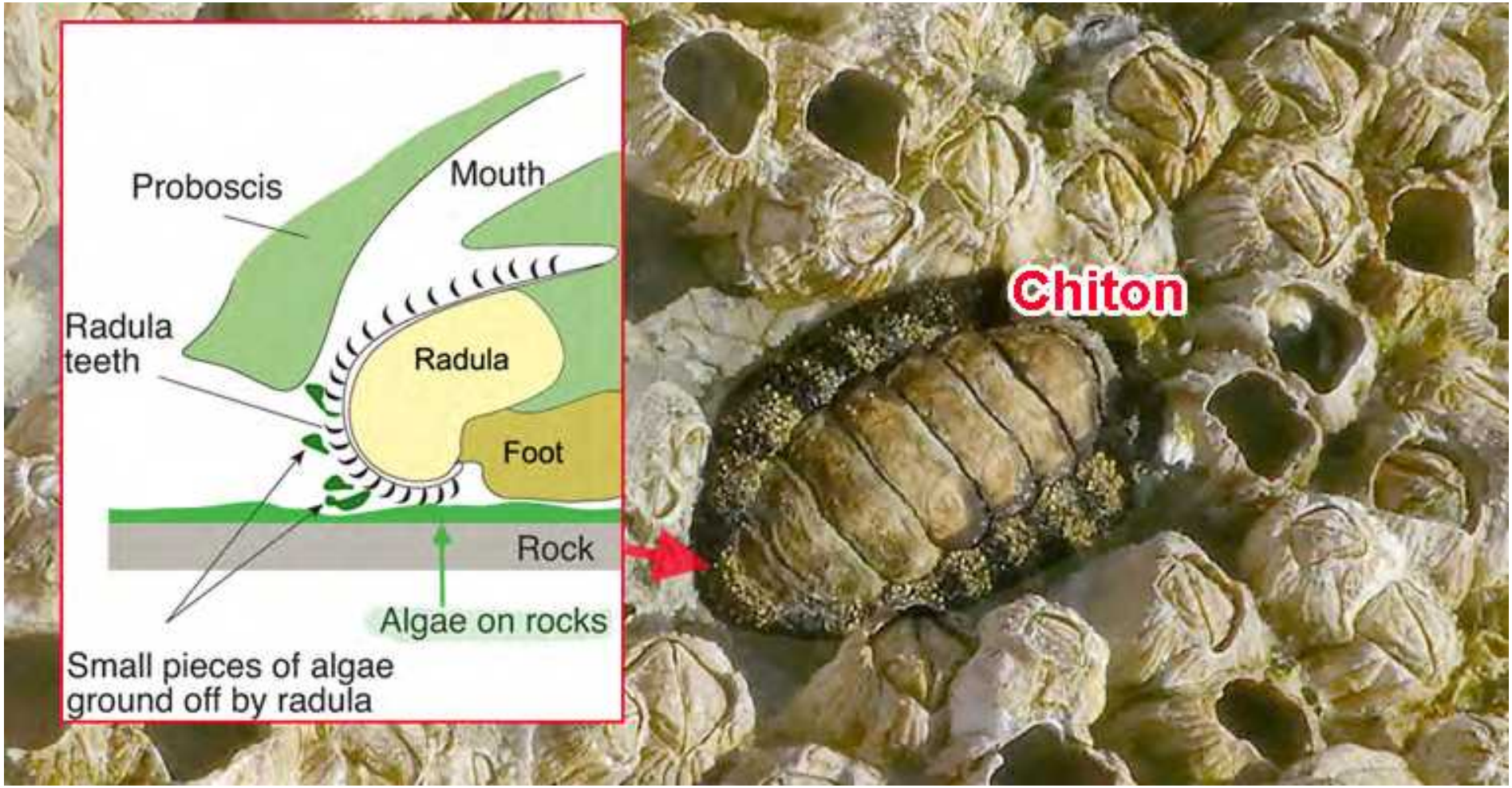
Benthic animals have a ventral mouth to feed on benthic organisms.



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Chitons have a specialized feeding mouth, like a radula, or modified mouth parts to scrape food off tough surfaces or bite through other shells.



Bob Moffatt

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Functional or physiological adaptations

- Buoyancy
- Mucous and poisonous secretions
- Colouration
- Respiration
- Salt water balance
- Specialized body parts
- Camouflage

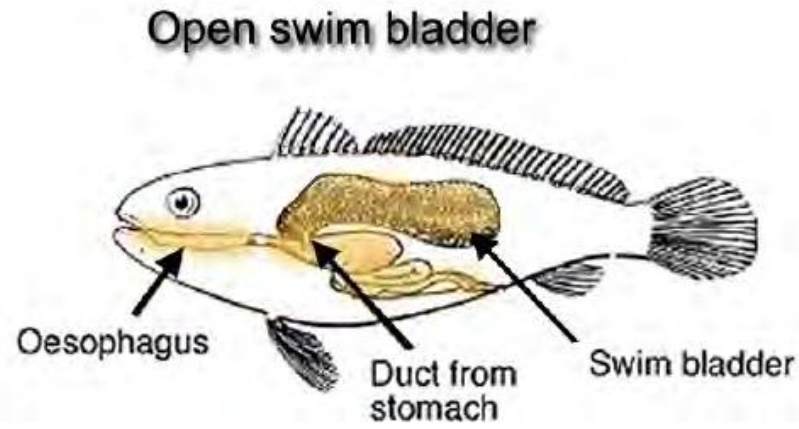


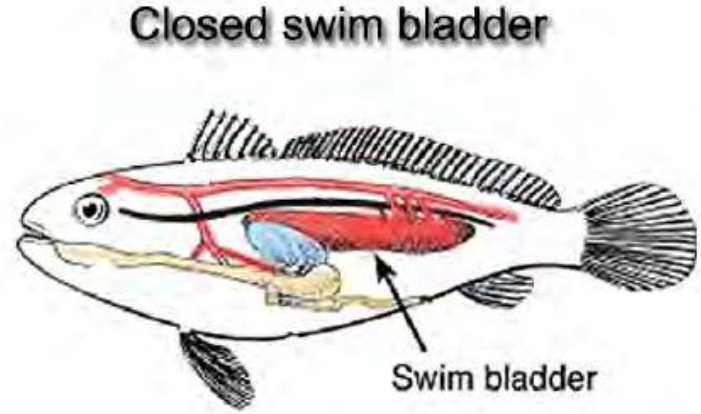
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Buoyancy

Some fish have an air bladder or swim bladder in which they can vary the amount of air and therefore, vary their density.

This allows these fish to float at different depths in the ocean. This air-bladder can be filled by gases dissolved in the blood or by rising to the surface to swallow air.





Jack Marsh

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Other organs that assist in the buoyancy of plants are air-filled bladders to keep them afloat.

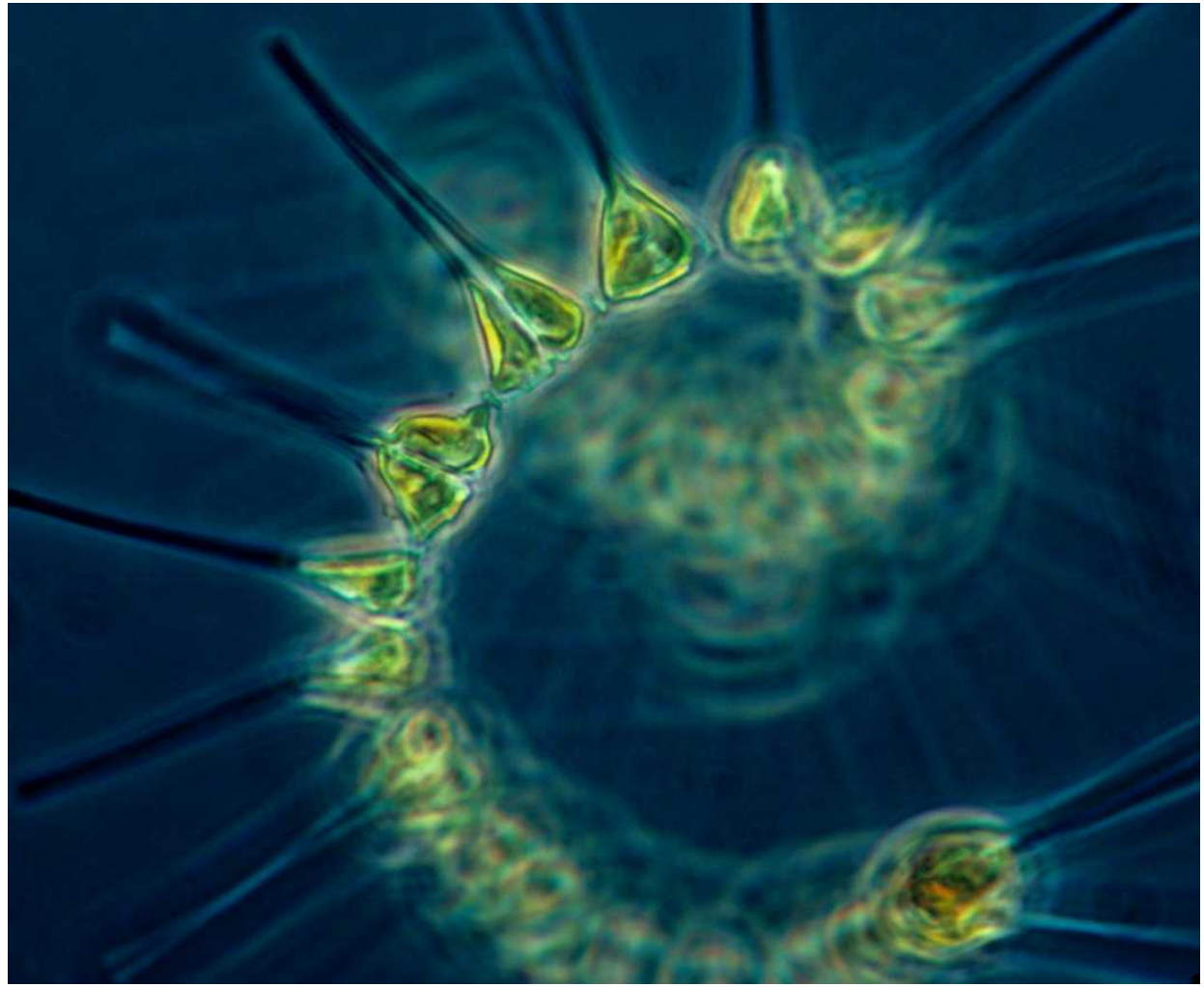


Mike Sugden

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Phytoplankton have air-filled vacuoles or oil droplets contained within their body to increase their buoyancy.

Some plankton have long spines to slow the rate of sinking and increase their surface area/volume ratio.

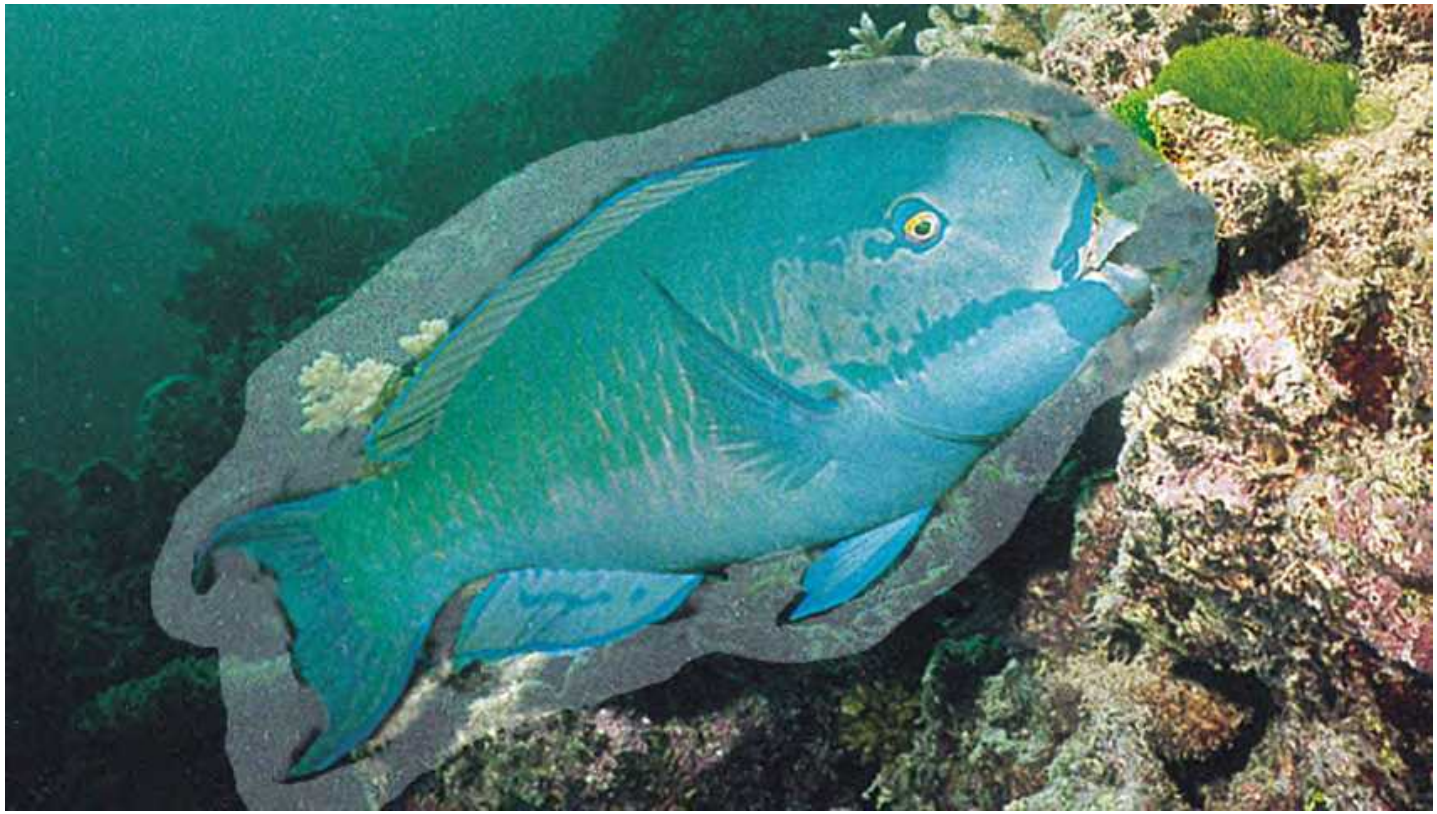


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Mucous and poisonous secretions

Some fish secrete a mucous bubble to make them ”chemically invisible” at night.



Bob Moffatt

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Many marine creatures produce a toxin which makes them poisonous to eat. Many of these toxins are concentrated in certain organs of the body such as the liver Eg Moray eels

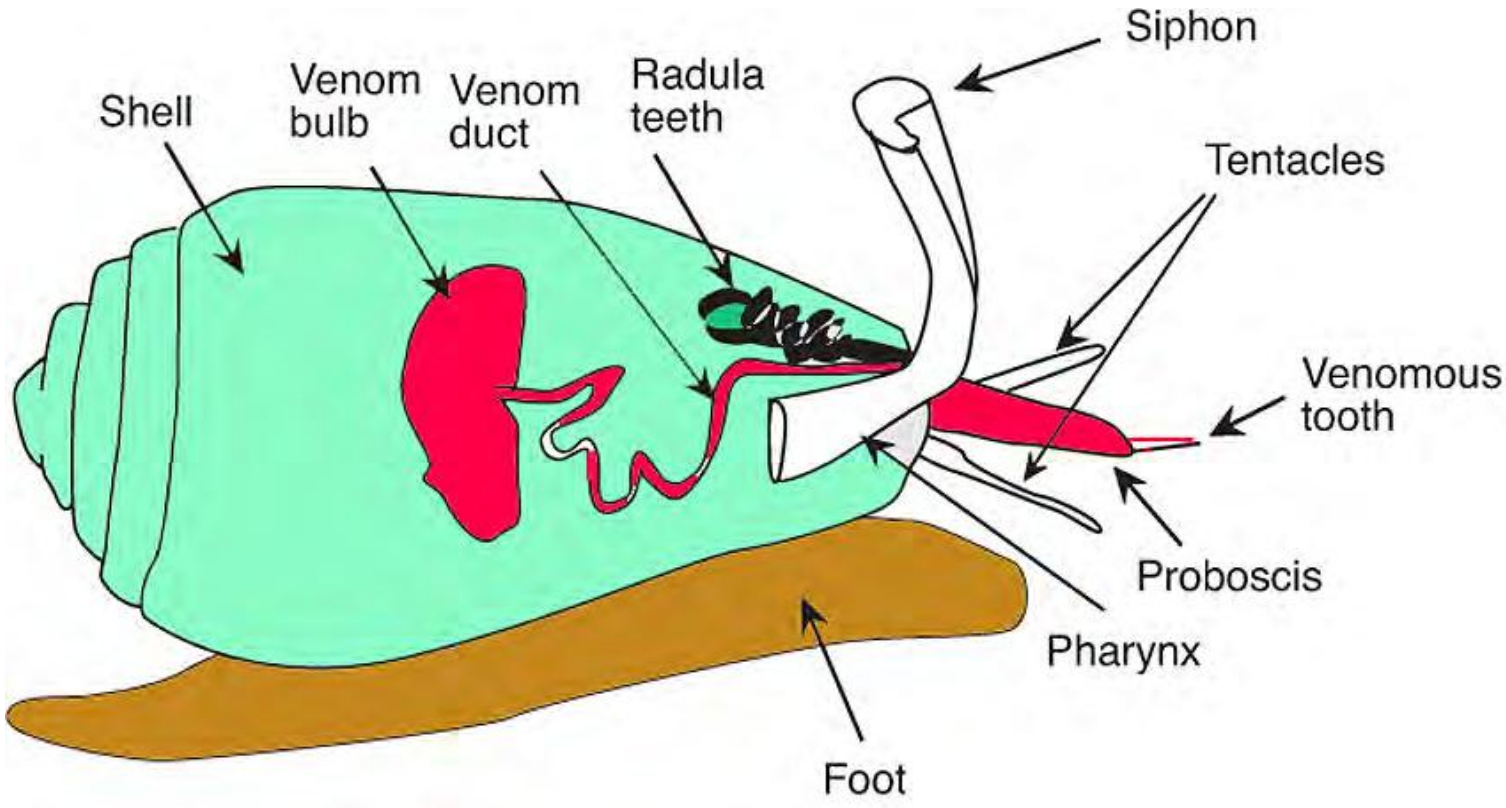


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Venom glands

Some animals such as stonefish, sea wasps, blue ringed octopus, cone shells, sea anemones and sea snakes are capable of injecting toxic substances (venom) into the attacking animal.



Bob Moffatt

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Colouration

Some fish have markings that hide the position of their eyes. Fish may have a ‘false’ eye marking on the back of their body.

This distinctive marking attracts the predator’s attention for attacks.

This marked part of the body has few vital organs and the fish has a good chance of surviving such an attack.



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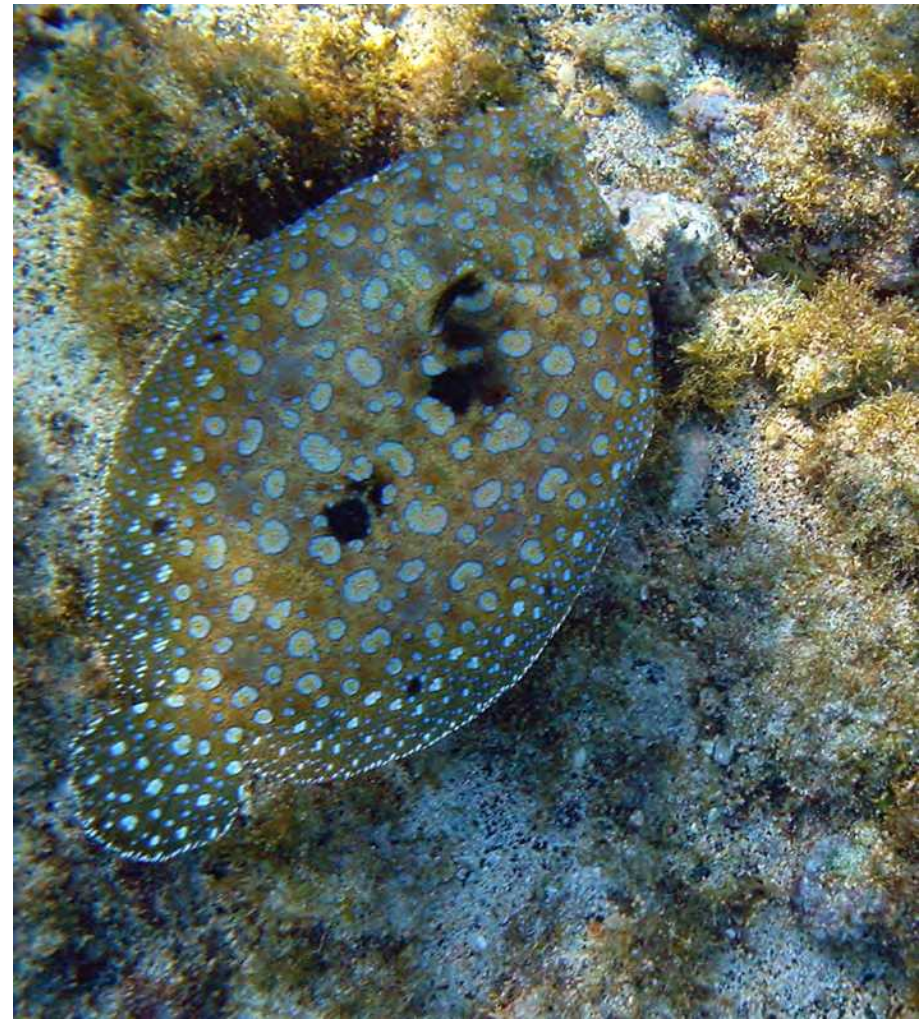
Colour change

Cells in the skin of some fish have the ability to change colour where pigments can be concentrated or dispersed throughout skin cells.

The pigments react to changing light intensity making the fish fade into the background.

Flounder is one such fish changing skin colour and pattern to blend in with the background.

When the fish is on the sandy bottom its colour is light, but when on a rocky bottom its pattern changes, becoming blotchy and much more black and white.



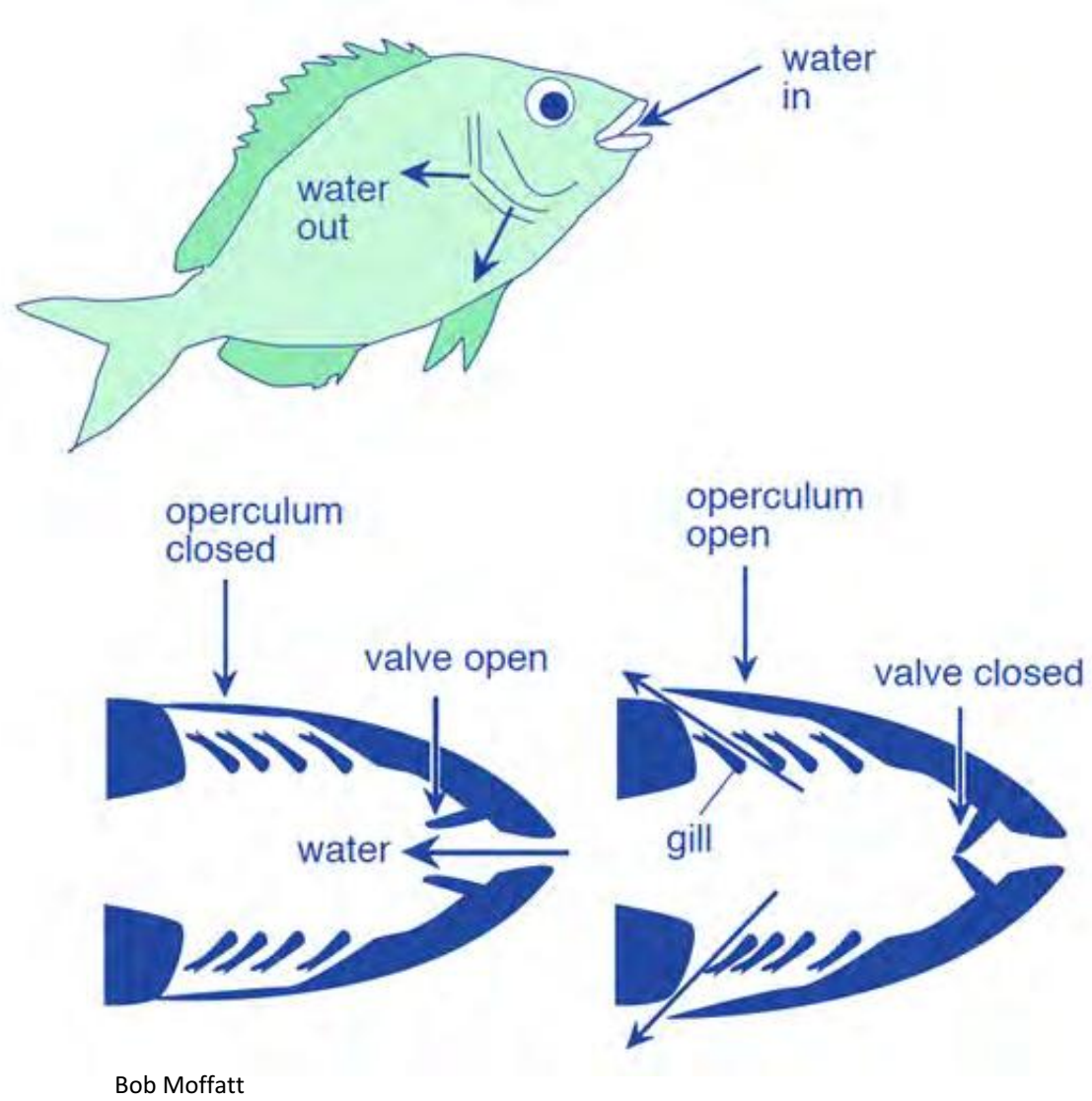
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Respiration

Fish extract oxygen from seawater at the gill surface. Water is taken into the mouth and pumped out over the gills.

The operculum opens and closes to allow water to escape and the oesophagus must close to prevent water from entering the stomach.

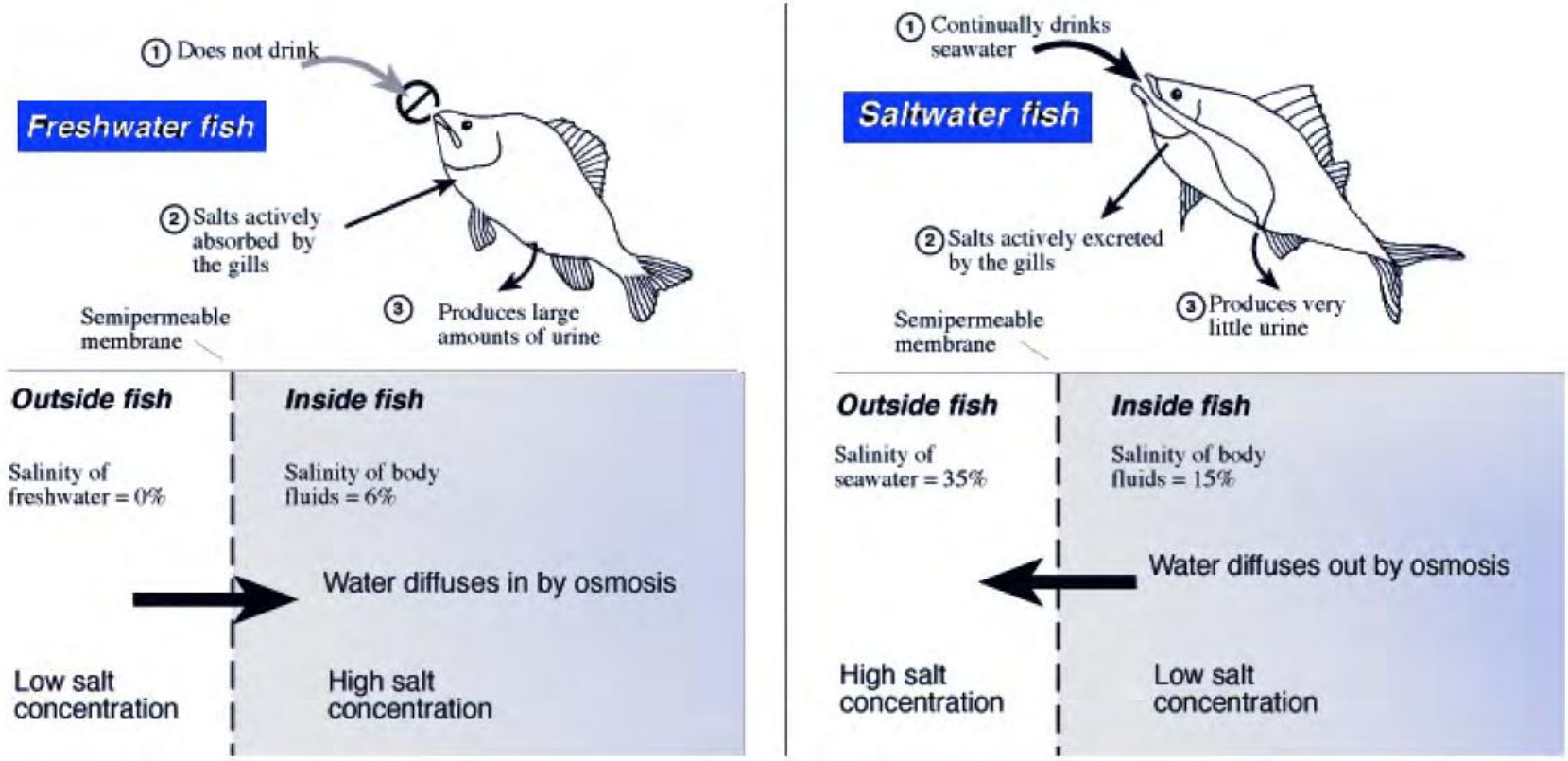


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Salt water balance

The kidneys of a fish allow it to drink seawater and excrete salts and produce very little urine. The ability of the kidney to process large amounts of salt water and maintain an internal salt balance is a physiological adaptation.

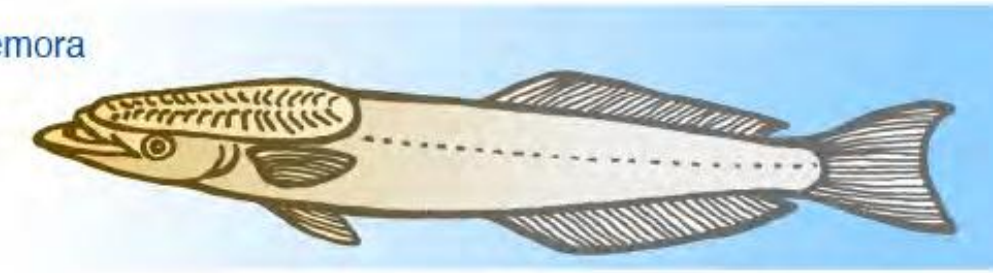


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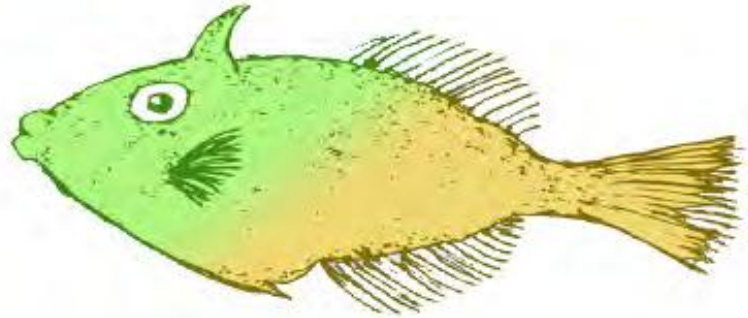
Specialized body parts

The remora needs a sucker to attach itself to its host. Its head has been modified for this purpose. The trigger fish, has its spine on its head so it can hook onto sea grasses, and the spine on the stingray is on the tail so it can flick up to wound its attacker.

Remora



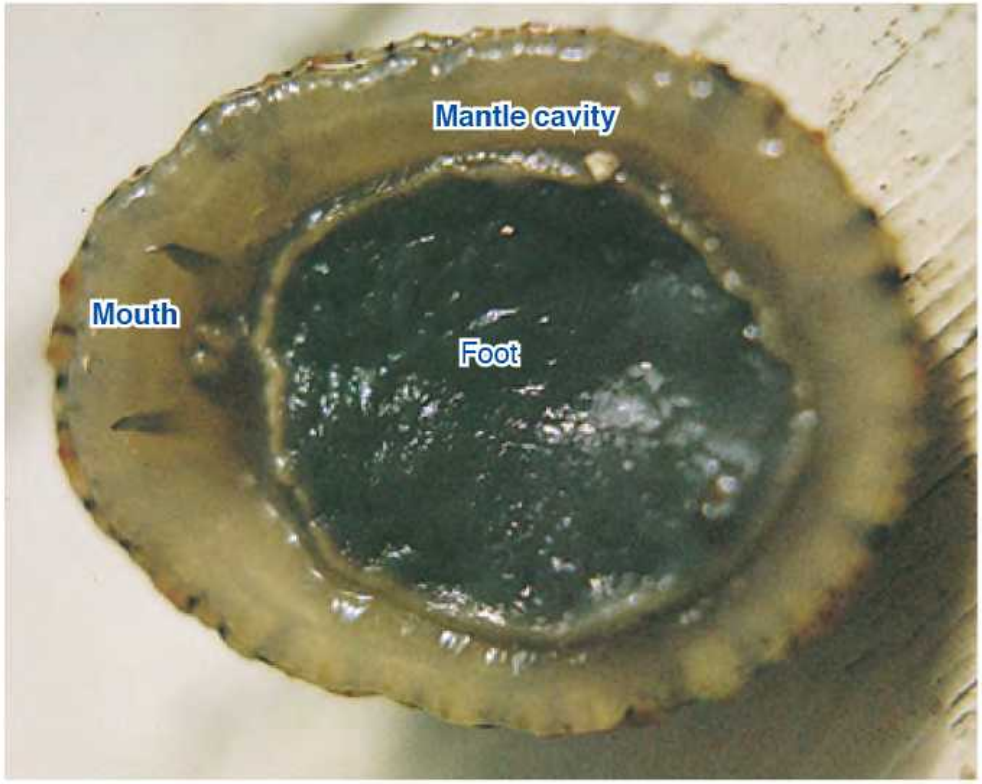
Trigger fish



Bob Moffatt

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The location of mouth parts is also important - dorsal mouths are surface feeders while ventral mouths are benthic feeders.
Limpet has a strong foot to hang on to rocks.







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A holdfast in kelps is a specialized adaptation as it holds the kelp in place unless it is washed away in a storm.

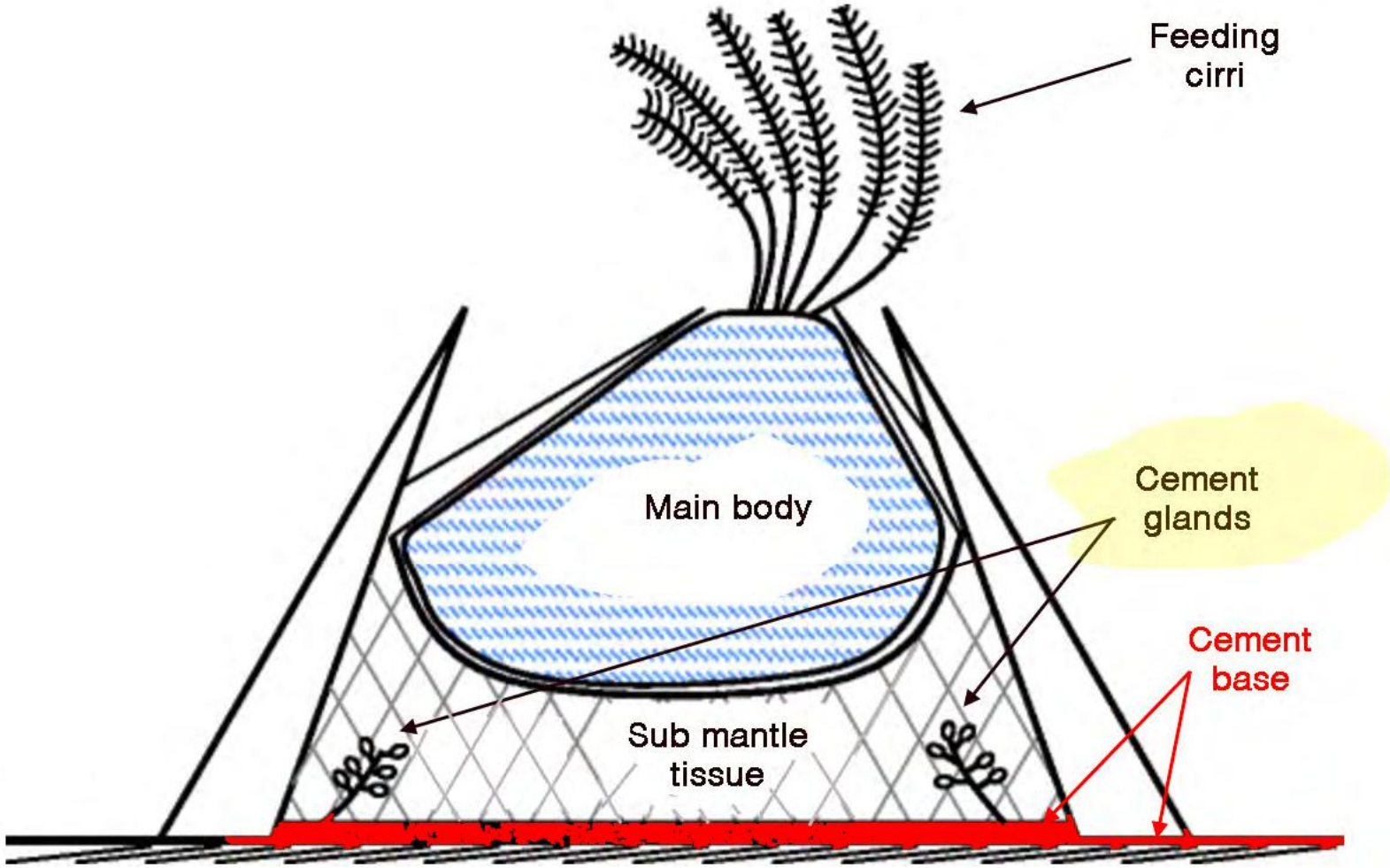


Holdfast torn from the sea floor by a storm

By Claire Fackler, CINMS, NOAA. - NOAA Photo Library: sanc0058, Public Domain, https://commons.wikimedia.org/w/index.php?curid=17972049

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Cement glands in barnacles stop them being washed away by waves.



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Camouflage and warning signals

The octopus can change colour and squirt ink as a distraction to predators.

The blue ringed octopus flashes warnings to possible predators.
Fish have eye spots so as to make predators think the tail is the head.



Neville Coleman

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Behavioural adaptations

- Escaping behaviours (burrowing, hiding, darting, secreting mucous shields, concealment)
- Schooling and aggregation
- Reproductive (care of young, courtship, nesting),
- Cyclical (daily, monthly, yearly, migration)
- Communication
- Territorality.



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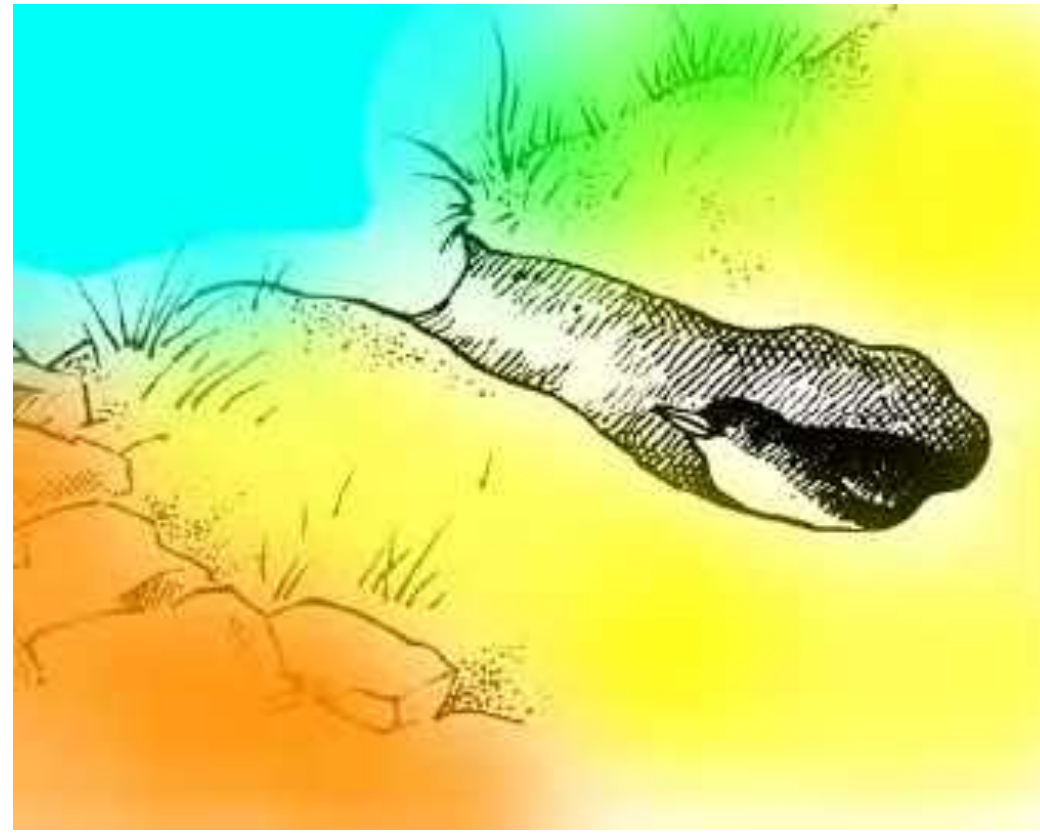
Escaping behaviours

(burrowing, hiding, darting, secreting mucous shields, concealment)

Most animals try to escape their predators.

The slower moving animals escape their predators by burrowing under the ground or hiding in holes.

Some animals even build their own hiding burrows.



Penguin in burrow

Sharyn Madder

© Wet Paper Publications

Many others are capable of short, sharp bursts of speed to escape the on-coming predator Eg Goby and shrimp



Bob Moffatt

© Wet Paper Publications

Schooling and aggregation

Schooling is the best known of these associations. A school is a large mass of fish that swim around together.

A large school of fish acts as a unit and increases the chance of survival of the fish.

The school appears as a huge object or animal and, in some cases, may scare off intending predators.

The erratic movement of the fish within the school may also make it hard for the predator to fix onto one fish as its prey and this confusion may allow the fish to escape.



Viewfinder

© Wet Paper Publications

Aggregation

Many sea creatures gather together in a temporary association called an aggregation. A good example of this is the Crown-of-thorns starfish.



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Starfish 'competing' for remaining live coral

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Reproductive

(care of young, courtship, nesting)

Many animals of the sea have elaborate behaviours that increase the chance of survival of their young.

One of the interesting examples of this behaviour is the seahorse where the male protects the young in a pouch on its body while the young are developing.

The female octopus once pregnant does not eat for the period of gestation. The young live off her body tissues and after birth, having spent all her energy, she dies.



Seahorse male with eggs

Neville Coleman (Bless you Neville)

© Wet Paper Publications

Some species carry their eggs in their mouths so they can protect them. This occurs in many of the Spotted barramundi. It produces few eggs which are protected by the female. The female carries the eggs in her mouth for a period of one month. These fish are called buccal incubators.



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Courtship behaviours

Many animals have courtship behaviour before mating.

A good example is the blue footed boobie

The male does a zig-zag dance when a female of breeding age enters his territory. The male then fertilizers the eggs and continues to watch over the eggs until they hatch. Birds, such as seagulls, are easy to observe in courtship rituals.



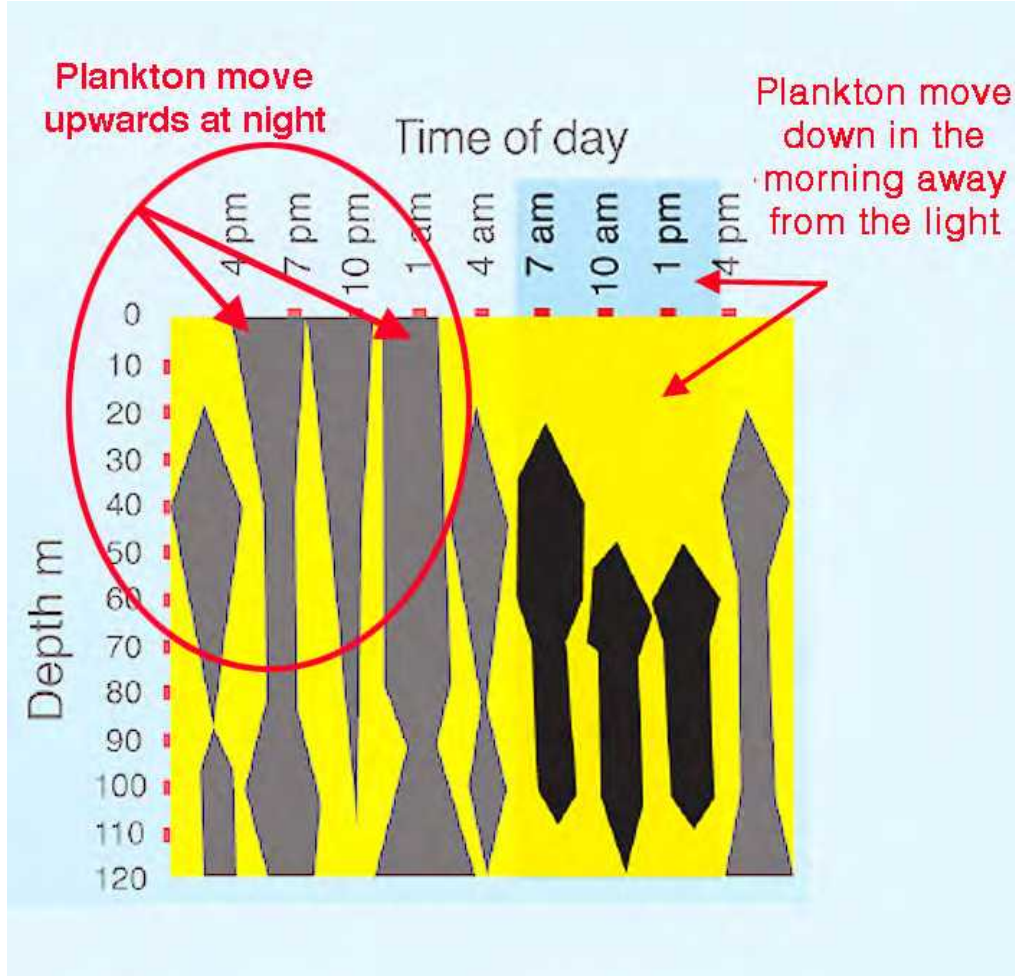
Bob Moffatt

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Cyclical (daily, monthly, yearly, migration)

Many animals exhibit rhythms of activity which take a daily cycle and are called circadian rhythms.

- A good example of this is the nocturnal activities of certain fish.
- Most of these fish are plankton hunters as plankton become more abundant in the water at night.



Bob Moffatt

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Another intriguing example is that of the fiddler crab where, even out of its own environment.

- The crab has been observed to carry out its same daily routine without the usual stimulus of the tides.



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Other animals have a seasonal rhythm that is well demonstrated by the reproductive behaviour of corals.

- A number of different species of corals will simultaneously release their spawn on mass each springtime following a full moon.



Stony coral spawning

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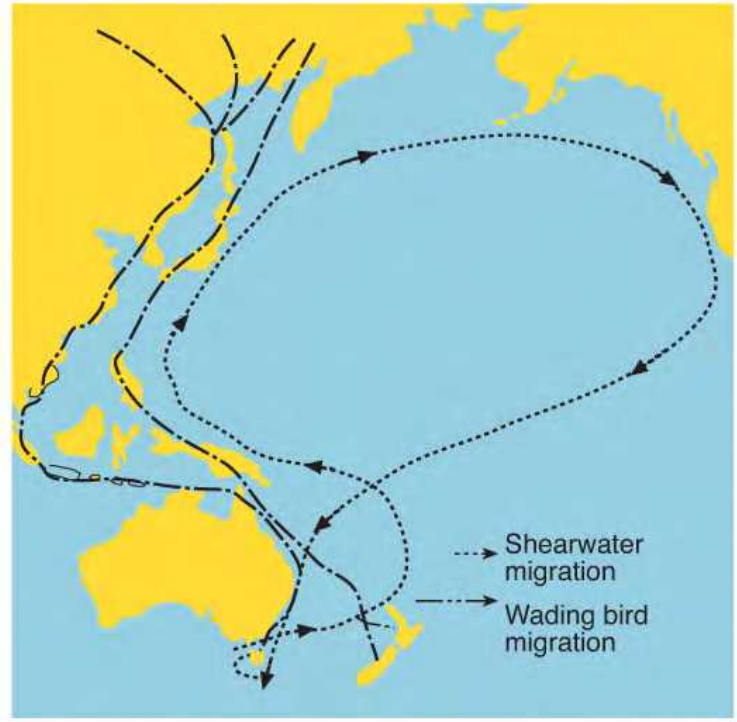
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Migration

Birds, whales, fish and squid are but a few examples of how animals seek to increase their chance of survival.

Shearwaters migrate each year to and from Great Barrier Reef islands.

Migration is believed to increase genetic diversity.





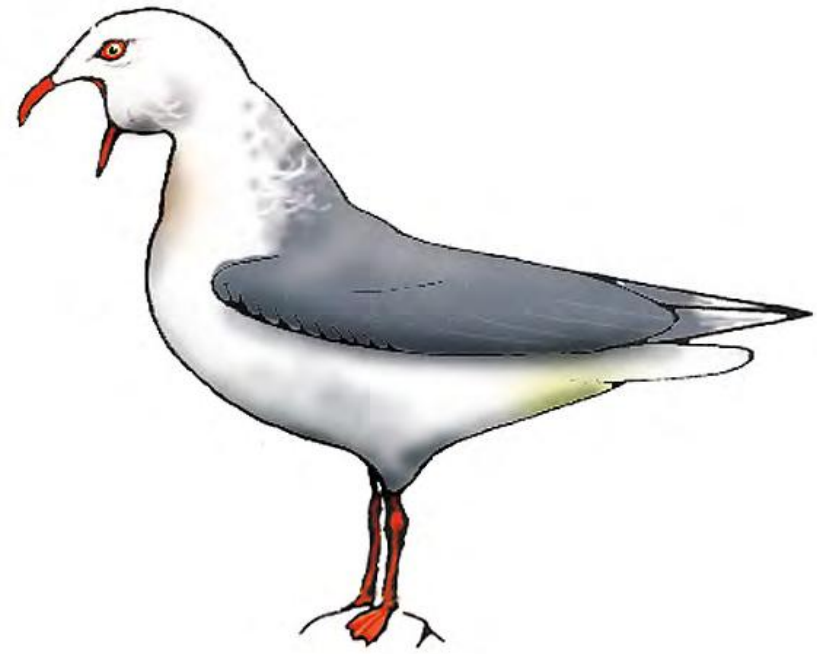
Bob Moffatt and Jim Kneale

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Communication

Fish make sounds by rubbing together body parts such as teeth, spines, or rough surfaces or by using the gases found in their swim bladder. Dolphins make clicks and whales squeal.

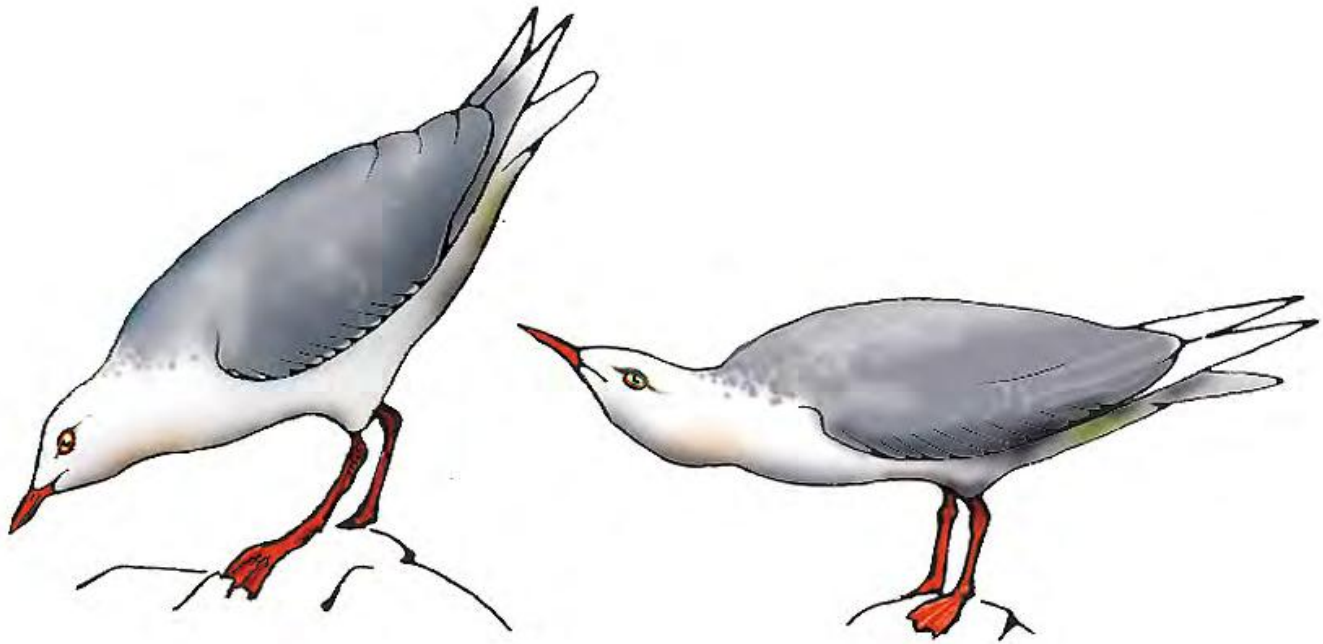
Shrimp snap and seagulls squark.



Kerry Kitzelman

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There is a never ending range of examples to show how animals communicate through sounds for defence, attack, reproduction or establishing themselves in a dominance hierarchy.



Seagull behaviours

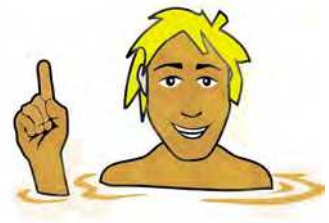
Kerry Kitzelman

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Mimicry

Mimicry in fish is a well established behaviour pattern especially colour.
Colours are used by many poisonous fish to indicate they have poison.

Other less poisonous fish have copied the colouration as a behavioural adaptation to fool predators they are poisonous.



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Territorality

An area which an individual or group of individuals defends is called its territory.

Damselfish are well known for their behaviour with dominance hierarchies established to protect territories.



Bob Moffatt

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Usually the biggest fish is the most dominant and has the greatest range. The hierarchy saves energy in population by reducing competition for food and mates.

In most cases, it is a breeding place that is defended, but it may be a particular food supply or shelter. Once an animal or group of animals establishes a territory other animals tend to stay away from this area.

Thus territorial behaviour tends to reduce fighting and competition for the resources.



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Question 1

Question 1: Read this..
An adaptation is a characteristic that helps an organism survive. Three types of adaptations include:

- structural
- functional
- behavioural

Now complete the table below to classify the type according to the description.

Criteria	Classification – structural, functional or behavioural
Body form	
Physiological	
Response to situations or stimuli	

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Q1. Answer

Criteria	Classification – structural, functional or behavioural
Body form	Structural
Physiological	Functional
Response to situations or stimuli	Behavioural

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Question 2

Question 2: Now look at the diagram of the porcupine fish and complete the table to identify structural, functional and behavioural adaptations.





Classification	Example of fish adaptations
Structural	
Physiological	
Behavioural	

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Q2. Answer

Classification	Example of fish adaptations
Structural	Spines
Physiological	Toxins in the skin which make you sick
Behavioural	Blows itself up to look much bigger than it really is





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Further questions

3. Give examples of how body cover, shape, camouflage, skeleton type, appendages and mouth parts can be used as examples of structural adaptations to enhance an organisms chance of survival.

4. Show how buoyancy, mucous and poisonous secretions, colouration, respiration, salt water balance, reproductive, specialized body parts and camouflage can be used as examples of functional or physiological adaptations to enhance an organisms chance of survival.

5. Give examples of the following behavioural adaptations - escaping behaviours (burrowing, hiding, darting, secreting mucous shields, concealment), schooling and aggregation, reproductive (care of young, courtship, nesting), cyclical (daily, monthly, yearly, migration), communication, territorality to enhance an organisms chance of survival.



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T059 Adaptations and survival



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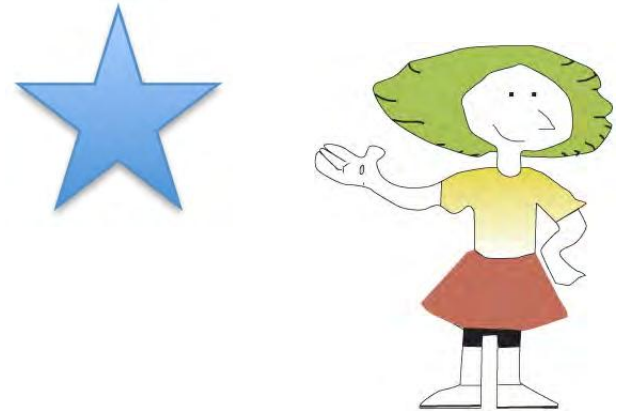
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Syllabus statement

At the end of this topic you should be able to ...

Describe

the role of adaptation in enhancing an organism's survival in a specific marine environment.



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Describe

- give an account (written or spoken) of a situation, event, pattern or process, or of the characteristics or features of something.



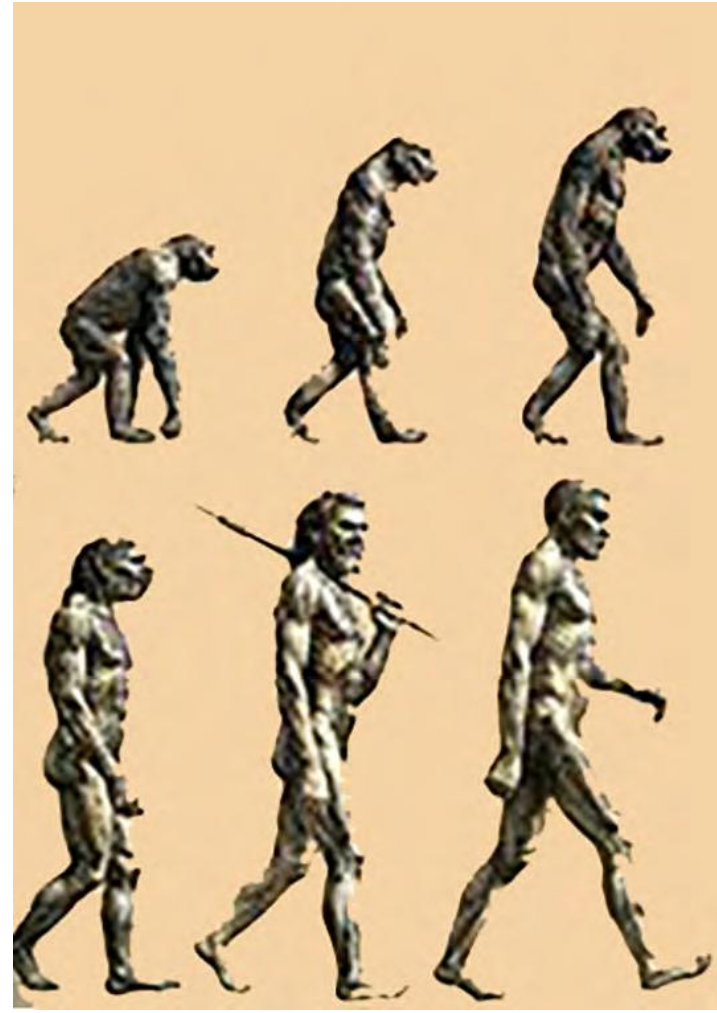


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The role of adaptation is to enhance the survival of an organism.

Firstly, it is the dynamic evolutionary process that fits organisms to their environment, enhancing their evolutionary fitness.

Natural selection is the only mechanism known to cause the evolution of adaptations, so many biologists would simply define an adaptation as a characteristic that has evolved by natural selection.



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Secondly, it is a state reached by a population during that process

Here the members of a population become better suited to some feature of their environment through change in a characteristic that affects their survival or reproduction.



By Robert Pittman - NOAA (http://www.afsc.noaa.gov/Quarterly/amj2005/divrptsNMML3.htm]) , Public Domain, https://commons.wikimedia.org/w/index.php?curid=1433661

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Thirdly, it is a phenotypic or adaptive trait, with a functional role in each individual organism, that is maintained and has been evolved by natural selection.

Note: Phenotypic is the composite of an organism's observable characteristics or traits.

A diversity of genetic traits increases genetic diversity.



Dennis Otten [GFDL (http://www.gnu.org/copyleft/fdl.html)
https://commons.wikimedia.org/wiki/File:Inia.jpg

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Organisms face a succession of environmental challenges as they grow, and show adaptive plasticity as traits develop in response to the imposed conditions.

This gives them resilience to varying environments.

References

https://en.wikipedia.org/wiki/Adaptation
https://en.wikipedia.org/wiki/Phenotype

Adaptive plasticity

https://en.wikipedia.org/wiki/Phenotypic_plasticity



Murray Waite

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Question

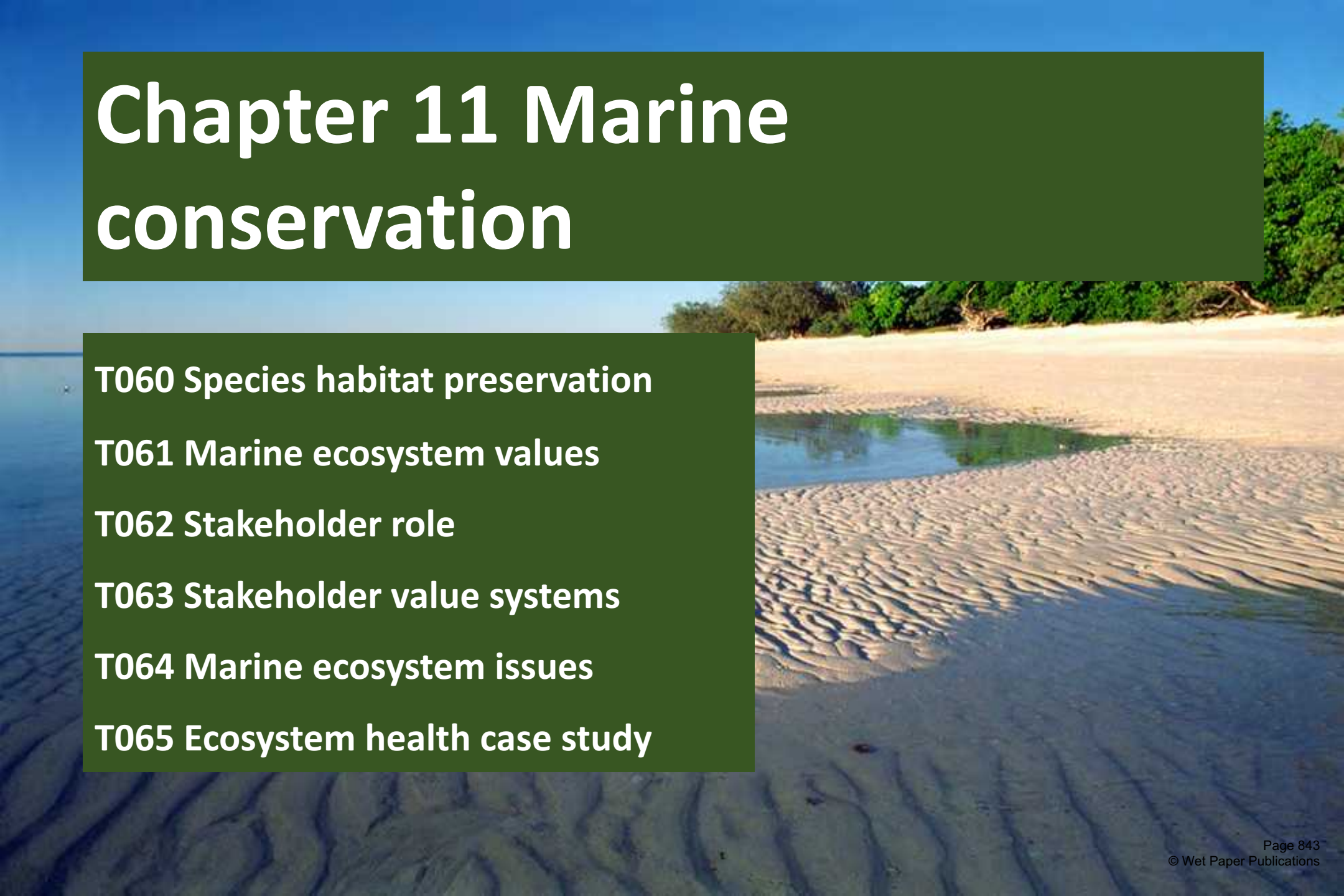
List three roles adaptation plays in enhancing an organism's survival in a specific marine environment.

Answer

1. Enhances individual organisms fitness
2. Populations become better suited to some feature of their environment
3. Genetic phenotype increases resilience to varying environments.

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Chapter 11 Marine conservation



T060 Species habitat preservation

T061 Marine ecosystem values

T062 Stakeholder role

T063 Stakeholder value systems

T064 Marine ecosystem issues

T065 Ecosystem health case study

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T060 Species habitat preservation



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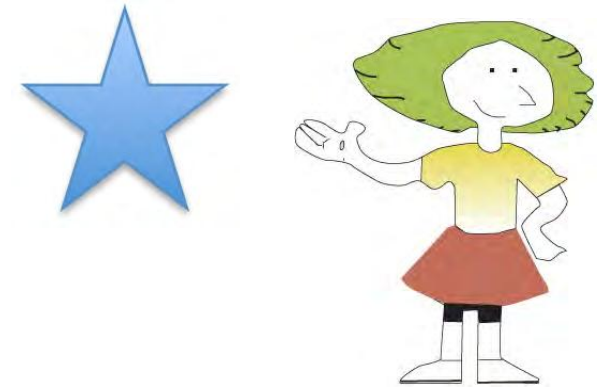
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Syllabus statement

At the end of this topic you should be able to ...

Recall

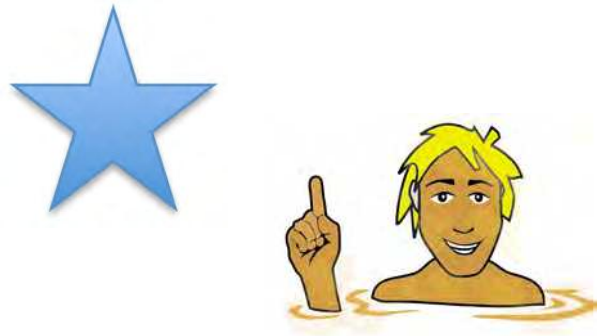
the arguments for preserving species and habitats (i.e. ecological, economic, social, aesthetic, ethical)



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Recall

remember; present remembered ideas, facts or experiences; bring something back into thought, attention or into one's mind



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Objective

Summarise the ecological, economic, social, aesthetic, ethical arguments for preserving species and habitats in a table.

Category	Argument
Genetic	
Ecological	
Economic	
Social	
Aesthetic	
Ethical	

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Answer

Summarise ecological, economic, social, aesthetic, ethical arguments for preserving species and habitats in a table.

Category	Argument
Genetic	Wild animals and plants are sources of genes for new adaptations to assist the survival in a changing environment. Ecosystems become more resilient to the loss of a species/reduction of population. Some species are keystone species, which if removed from the ecosystem can lead to many other species becoming extinct
Ecological	More species increases food web complexity. If prey or predator is lost other species can fill in gap. Life-support service value e.g. stable climate
Economic	People take vacations on areas surrounded by natural beauty and ntional parks (examples: snorkelling, fishing, boating, sailing, hiking) Unknown value in the potential of the species for agriculture, medicine, genetic diversity and biotechnology The sea is also a vast source of commercial resources such as oil and gas, which help run the electricity in your school.
Social	Provide a place for people to socialize - Let's all go for a surf, paddle, swim – source of networking, buildings environmental groups. OR Different societies need to defend environmental protection. Biodiversity should be preserved for its own sake as humans have a responsibility to act as stewards of the Earth.
Aesthetic	Source of beauty. People rely on wild places for spiritual fulfillment Nature can provide inspiration for the arts eg: music, poetry, painting, stories Surfers have a special relation with the sea which leads to the phrase - "only a surfer knows the feeling". I am sure you have your OWN special feelings and it is for these that habitats and species are worth preserving.
Ethical	Each species has a right to exist (a bioright) which is unrelated to human needs/ Habitats should be preserved for their own sake. Humans have a responsibility to act as stewards of our oceans and land

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Genetic

Wild animals and plants are sources of genes for new adaptations.

This assists survival in a changing environment.



Viewfinder

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Ecosystems become more resilient to the loss of a species/reduction of population.



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Some species are keystone species, which if removed from the ecosystem can lead to many other species becoming extinct.



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Ecological

More species types and numbers increases food web complexity.

Greater biodiversity provides greater ecosystem health.

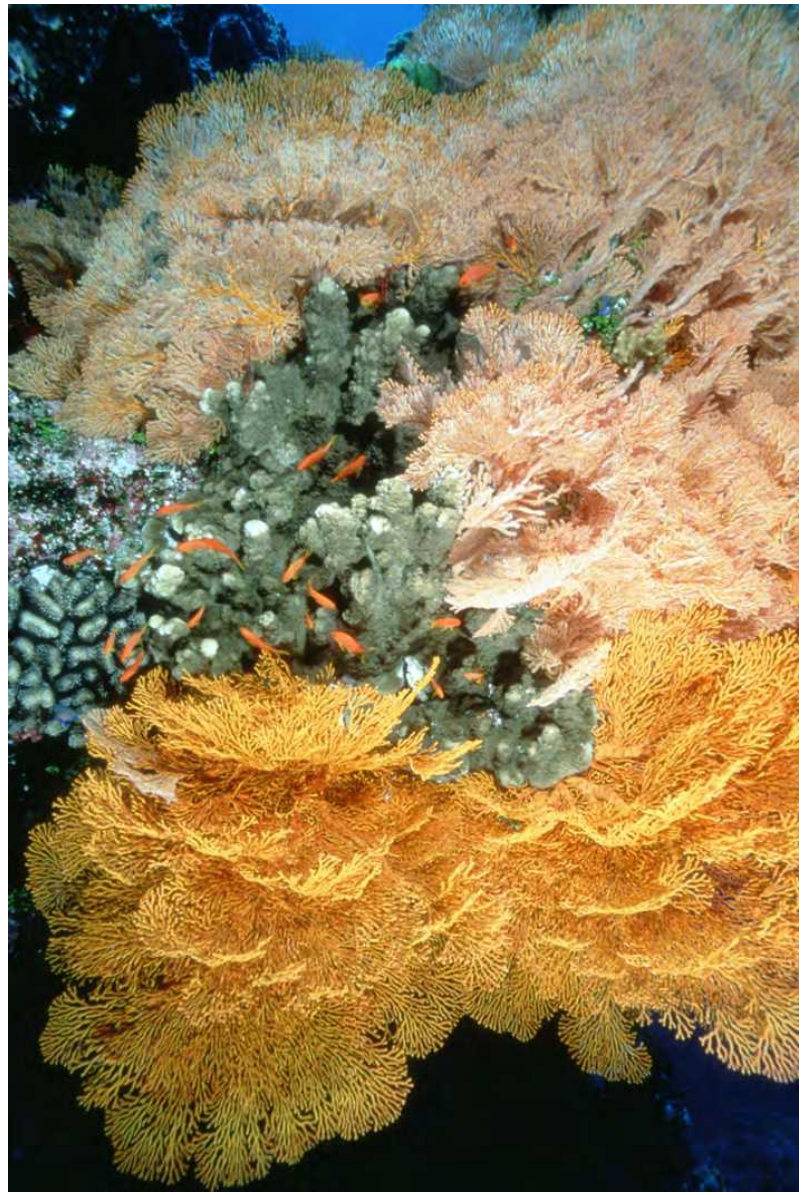


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If one type of prey or one type of predator is lost, other species can fill in the gap.

For example, if one type of coral is more tolerant to pollution than another, it will replace the “weaker” type to allow continuation of the species.



Viewfinder

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In the “big picture”, habitats play a vital role as life-support services. The ocean adjacent to the land provides a place for transport of reproductive materials and stages.

For example, mangrove seeds can be dispersed, barnacle larvae can grow and migrate back to shore.



Viewfinder

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Economic

People take vacations on areas surrounded by natural beauty and national parks.

The tourism industry can flourish, bringing millions of dollars into countries economies.



Viewfinder

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Economic

As part of their holiday, they can go snorkelling, fishing, boating, sailing, hiking creating a multitude of service industry jobs.



Viewfinder

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Unknown value also exists in the potential of the species for agriculture, medicine, genetic diversity and biotechnology, as mentioned in the conservation section of the syllabus.

Remember this one from Oceanography?

At the end of this topic you should be able to ...

Understand that the economic development of a nation and the value placed on marine environment, including the Exclusive Economic Zone (EEZ), affects decisions relating to resource management.



And

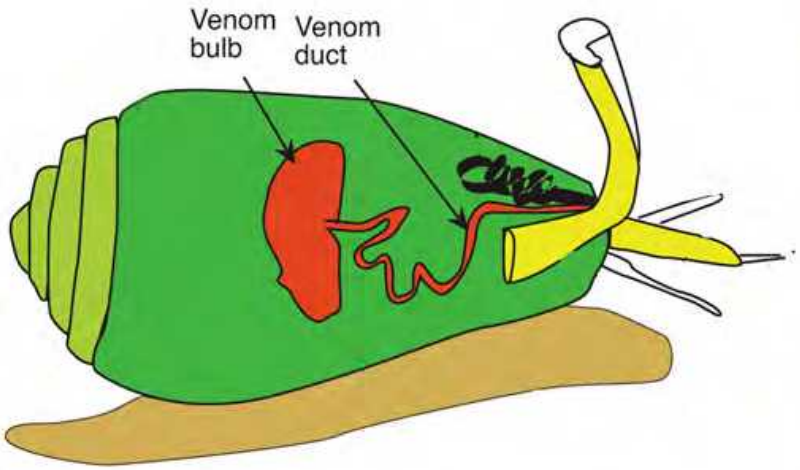
Argue that knowledge of the oceans is limited and requires further investigation

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Remember this one (from oceanography)?

Information from ocean exploration is important to everyone. Unlocking the mysteries of deep-sea ecosystems can reveal new sources for medical drugs, food, energy resources, and other products.

Could conefish venom contain a cure for cancer?





Cone shell and venom gland

Photo Neville Coleman, Illustration Bob Moffatt

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Gas platforms drill deep into the ocean floor extracting natural gas, offloading to ships or undersea pipelines and is then processed on shore.



Harriet A gas platform
Image CSIRO

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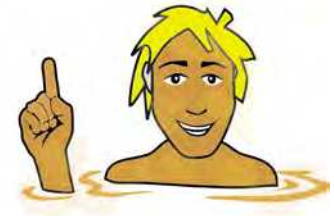
Social

Provide a place for people to socialise - Let's all go for a surf, paddle, swim – source of networking and building environmental groups.



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One syllabus interpretation – what's yours?



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Preserving our clean water provides a healthy environment for us all.



Surfing Australia - reproduced with permission

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Australia’s clean water image is promoted around the world.



Surfing Australia - reproduced with permission from the bring back Kirra campaign (thanks Steph)

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Different societies need to defend environmental protection.

“Biodiversity should be preserved for its own sake as humans have a responsibility to act as stewards of the Earth”



Another syllabus interpretation

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Aesthetic

The ocean is a source of beauty.

People rely on wild places for spiritual fulfillment and the ocean provides limitless opportunities.



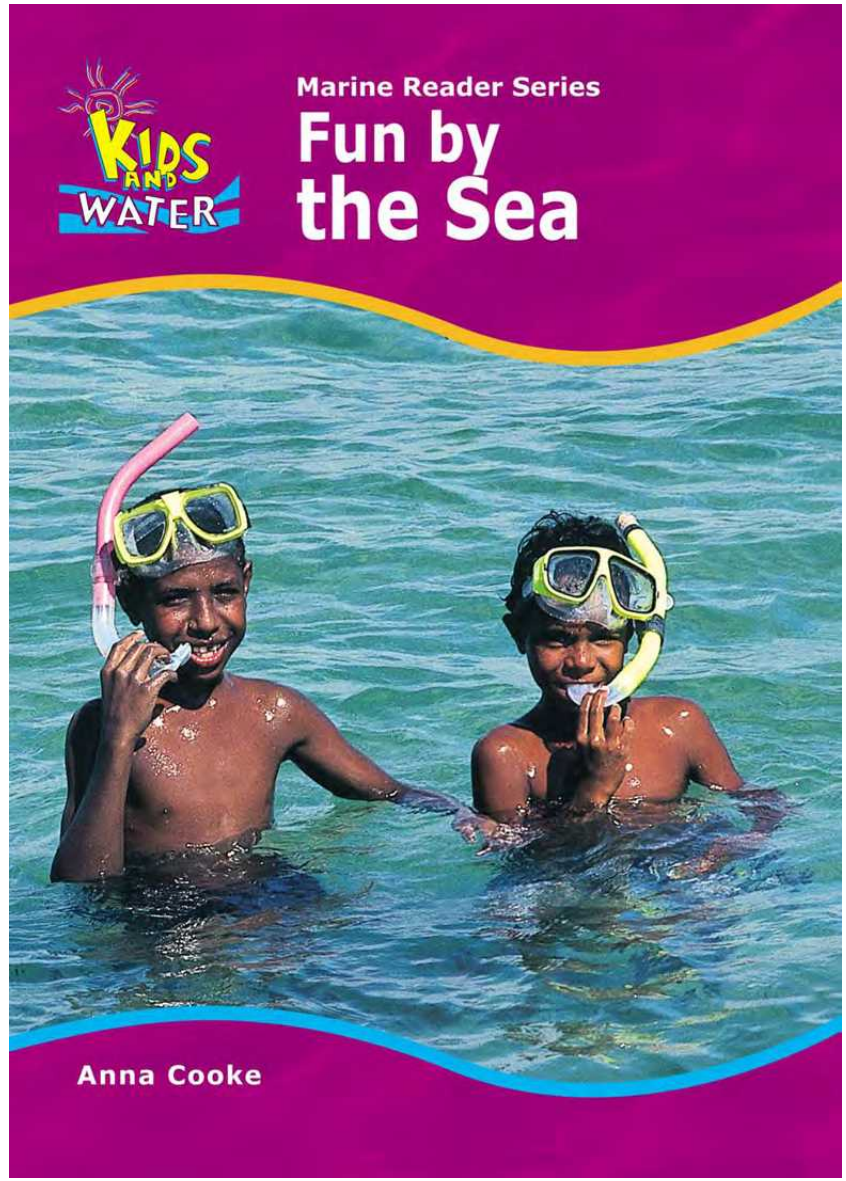
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Habitats can provide inspiration for the arts.

For example,

Music, poetry, painting, photography and stories.



Neville Coleman and Kids and Water

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Surfers have a special relationship with the sea which leads to the phrase - “only a surfer knows the feeling”. I am sure you have your OWN special feelings and it is for these that habitats and species are worth preserving.



By Steve Jurvetson from Menlo Park, USA - Step Into Liquid, CC BY 2.0
https://commons.wikimedia.org/w/index.php?curid=3561785

So what is your special marine habitat that you would like preserved?



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Ethical

Each species has a right to exist (a bioright) which is unrelated to human needs.

This idea holds that some, or all, non-human animals are entitled to the possession of their own lives and that their most basic interests - such as the need to avoid suffering - should be afforded the same consideration as similar interests of human beings.



Left By Alan Wilson - www.naturespicsonline.com: [1], CC BY-SA 3.0, https://commons.wikimedia.org/w/index.php?curid=38456823



Right By Andreas Weith - Own work, CC BY-SA 4.0, https://commons.wikimedia.org/w/index.php?curid=52745369

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Habitats should be preserved for their own sake for future generations.



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Humans have a responsibility to act as stewards of our oceans and land.



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Video

SPECIES RICHNESS AND A WHALE

https://www.youtube.com/watch?v=-bE-Pydad7U

The whale example shows why a habitat should be protected as well as the importance of a keystone species.

Or the syllabus recommends:

“The truth about consumerism” –

https://www.youtube.com/watch?v=gWWTD-c2gCE

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Question

Summarise ecological, economic, social, aesthetic, ethical arguments for preserving species and habitats in a table.

Category	Argument
Genetic	
Ecological	
Economic	
Social	
Aesthetic	
Ethical	

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T061 Marine ecosystem values



Bob Moffatt

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Syllabus statement

At the end of this topic you should be able to ...

Describe

the direct and indirect values of marine ecosystems of Australia





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Describe

Give an account (written or spoken) of a situation, event, pattern or process, or of the characteristics or features of something



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Objectives

- Define the terms ecosystem valuation and ecosystem services giving examples of each.

- Define direct and indirect ecosystem valuation and give Australian examples to show the difference.



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Ecosystem valuation

is a strategy used by stakeholders to assign an economic value to an ecosystem or the services it can provide.

Ecosystem service

Is the benefits that humans freely gain from the natural environment and from properly-functioning ecosystems.

References

https://en.wikipedia.org/wiki/Ecosystem_valuation
http://www.marbef.org/wiki/Non-use_value:_bequest_value_and_existence_value



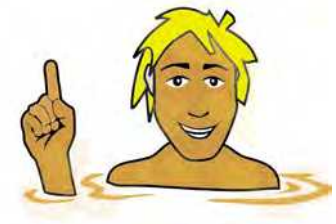
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Example - valuation

It has been estimated that the combined value of the ecosystems of the Earth in 1995

was worth more than ($33T) each year;

more than the whole human exchange economy ($25T).



Reference: Costanza, Robert (1997). "The value of the world's ecosystem services and natural capital.". Nature. 387.

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Example - service

- Provisioning of clean drinking water
- Decomposition of wastes
- Filtering of water by riparian vegetation
- Movement of sand into sand dunes



Good riparian vegetation provides a creek and subsequent catchment with good quality water

By U.S. Department of Agriculture - [1] (context), Public Domain, https://commons.wikimedia.org/w/index.php?curid=244190

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Direct valuation example

This is the value equivalent to its ecological yield.

That is, valued as it would be on commodity markets.



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Seafood exports

Number of local fish that could be harvested to be sold in a supermarket or exported overseas.



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Salmon for the Australian market flown from Hobart to other Australian States creates many jobs along the supply chain.





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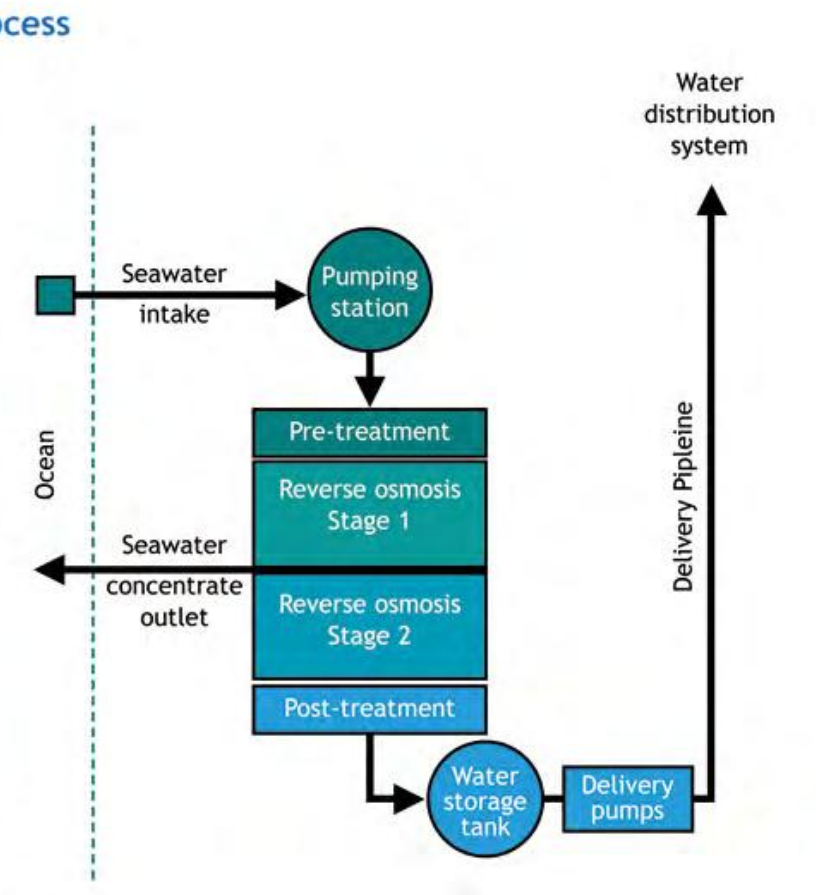
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Example: Desalinated water

Volume of desalinated seawater that can be sold to a service provider.



Tugan desalination plant Qld Government copyright



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Example: Offshore oil

Number of barrels of oil that can be harvested from an offshore oil platform.



Photo courtesy Esso Australia

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Example: Oysters

Number of oysters that can be sold from as oyster lease.



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Example: surfing waves

Number of waves that can be caught by surfers on a series of surfing breaks determines if they travel to that place and spend money on the way.



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Example coral reefs

Value

Ecosystem services [edit]

Coral reefs deliver ecosystem services to tourism, fisheries and coastline protection. The global economic value of coral reefs has been estimated to be between US $29.8 billion[6] and $375 billion per year.[7]

The economic cost over a 25-year period of destroying one kilometer of coral reef has been estimated to be somewhere between $137,000 and $1,200,000.[124]

To improve the management of coastal coral reefs, the World Resources Institute (WRI) developed and published tools for calculating the value of coral reef-related tourism, shoreline protection and fisheries, partnering with five Caribbean countries. As of April 2011, published working papers covered St. Lucia, Tobago, Belize, and the Dominican Republic. The WRI was "making sure that the study results support improved coastal policies and management planning".[125] The Belize study estimated the value of reef and mangrove services at $395–559 million annually.[126]

Bermuda's coral reefs provide economic benefits to the Island worth on average $722 million per year, based on six key ecosystem services, according to Sarkis *et al* (2010).[127]

Shoreline protection [edit]

Coral reefs protect shorelines by absorbing wave energy, and many small islands would not exist without reefs. Coral reefs can reduce wave energy by 97%. Reefs can attenuate waves as well as or better than artificial structures designed for coastal defence such as breakwaters.[128] An estimated 197 million people who live both below 10 m elevation and within 50 km of a reef consequently may receive risk reduction benefits from reefs. Restoring reefs is significantly cheaper than building artificial breakwaters in tropical environments. Expected damages from flooding would double, and costs from frequent storms would triple without the topmost meter of reefs. For 100-year storm events, flood damages would increase by 91% to $US 272 billion without the top meter.[129]

Fisheries [edit]

About six million tons of fish are taken each year from coral reefs. Well-managed reefs have an average annual yield of 15 tons of seafood per square kilometer. Southeast Asia's coral reef fisheries alone yield about $2.4 billion annually from seafood.[124]



Island with fringing reef off Yap, Micronesia[130]

https://en.wikipedia.org/wiki/Coral_reef

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Indirect valuation

is the value attributed to indirect utilisation of ecosystem resources through the opportunities that ecosystems provide.



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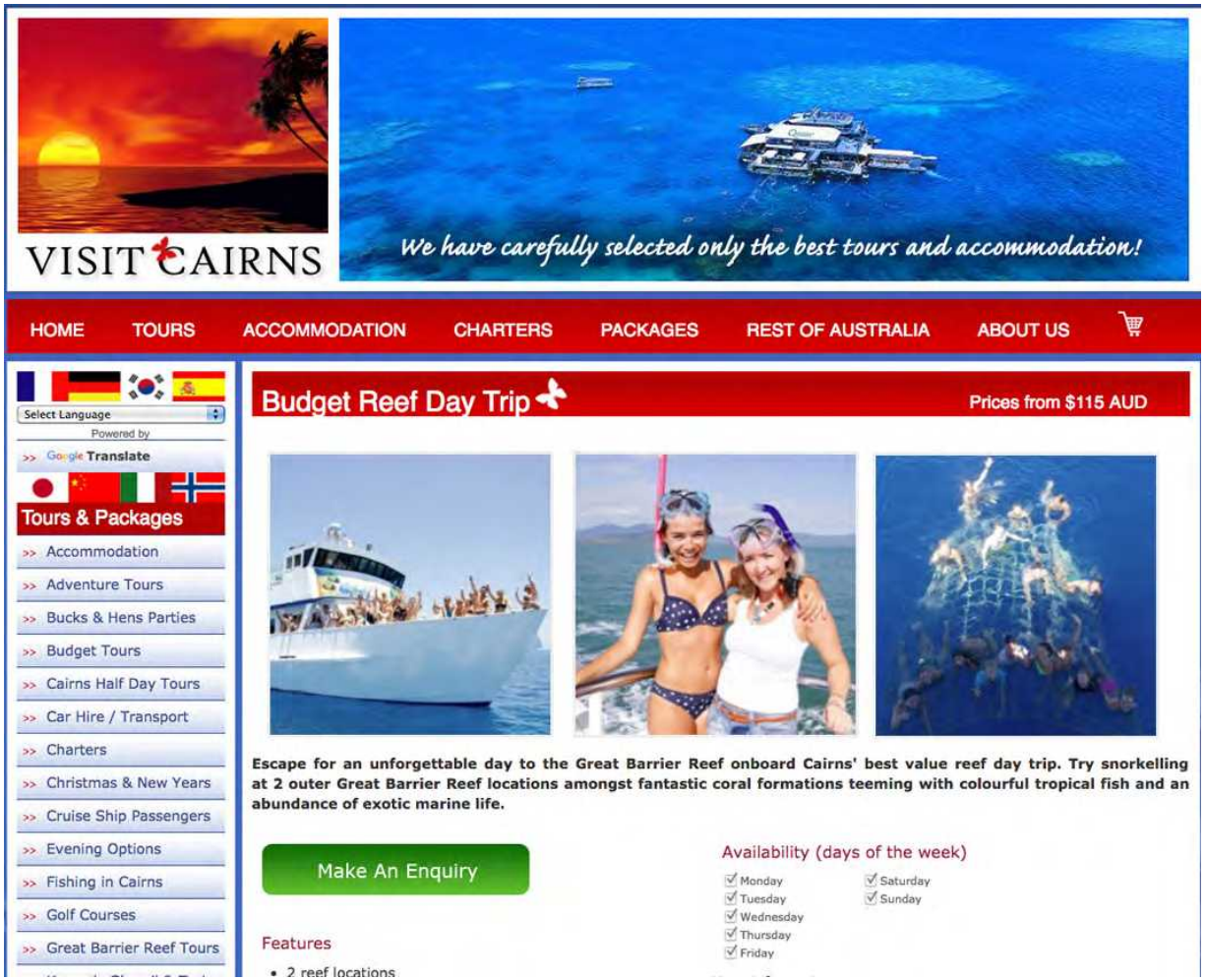
Example - The number of dinners sold in a seafood restaurant.



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Example:
The number of tickets sold on a reef trip.



http://www.visitcairns.com.au/

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Example:
The number of accessories sold in a surf shop.



















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Example:
The number of fishing rods and tackle sold in a retail outlet.



Photos Bob Moffatt



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The Wiki article, from which much of this discussion is taken, also argued that there were four others:

1. **Option value** attributed to preserving the option to utilise ecosystem services in the future

2. **Existence value** attributed to the pure existence of an ecosystem.

3. **Altruistic value** based on the welfare the ecosystem may give other people.

4. **Bequest value** based on the welfare the ecosystem may give future generations.



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The authors make this observation:

"Such valuation, and that of the effectiveness of various environmental health measures that affect the value of life and quality of life, are usually thought to be part of economics.

Natural capital and individual capital are studied in ecology as living systems, however, this does not extend to the economics of valuation by which they are related".



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Since animals do not put explicit prices on ecosystems they use, but do behave as if they are valuable, e.g. by selecting one territory vs. another, defending their territories, etc., it is mostly a matter of definition whether ecology should include valuation as an issue.

What do you think?



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Read more at

REF: https://en.wikipedia.org/wiki/Ecosystem_valuation



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Questions

Question 1.

Define the terms ecosystem valuation and ecosystem services giving examples of each.

Question 2.

Define direct and indirect ecosystem valuation and give Australian examples to show the difference.



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T062 Stakeholder roles



Bob Moffatt

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Syllabus statement

At the end of this topic you should be able to ...

describe

the role of stakeholders in the use and management of marine ecosystems.





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Describe

Give an account (written or spoken) of a situation, event, pattern or process, or of the characteristics or features of something



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Objectives

1. Define the term stakeholder as it applies to the use and management of marine ecosystems.

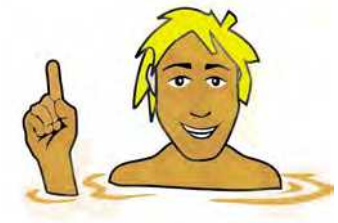
2. Using the stakeholder roles A – C below, give example of the roles they would play in the use and management of marine ecosystems.

Role list:

A. Interacting with planning agencies

B. Providing research information for decision-making processes, and

C. Education to inform users and the wider community.



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Definition

Stakeholders are

Individuals, groups or organisations who are, in one way or another,

interested, involved or affected (positively or negatively)

by a particular project or action toward marine resource use.



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Stakeholder role	Example of role
A. Interacting with planning agencies	
B. Providing research information for decision-making	
C. Education to inform users and the wider community.	

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Stakeholder role	Example of role

A. Interacting with planning agencies	- Give advice
	- Represent fellow stakeholders
	  o Organise meetings
	  o Make presentations
	  o Collect and summarise information
	  o Read/send emails
	  o Prepare summary documents
	  o Run a campaign
	  o Network with other stakeholders
	- Go to meetings and participate in discussions
	- Fill out survey forms, take back to group
	- Read and review policy documents
	- React to proposed policy and practices
	- Make media statements to support or oppose proposals

B. Providing research information for decision-making	- General mapping of the area (using charts, satellite images and aerial photography); - Site mapping using underwater scuba (quadrats and transects, underwater video) and boats (echosounders, sonar, bottom grabs,drop video); - Specific surveys of certain species (eg keystone, threatened and indicator species); - Surveys of water quality and levels of pollutants (using electronic and chemical tests); - Tests to establish toxic levels, so regulations on discharges can be developed (using live experiments); - Social and economic surveys to identify different human uses, and economic and cultural values (using interviews and questionnaires); - Data storage and analysis of information (using computer databases such as Geographic Information Systems GIS).
C. Education to inform users and the wider community.	- Media releases and social media - key board warrior - Assist in design of campaigns - Networking with other groups - Campaigning through social media, TV media shows - Becoming involved in politics – joining/supporting an political party - Election campaigning

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A. Interacting with planning agencies

Role - give advice

Depends on who you are:

- developer,
- environmentalist,
- port authority.



Kerry Kitzelman

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OR
young political party members.



Kerry Kitzelman

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Role - represent fellow stakeholders

- Organise meetings
- Make presentations
- Collect and summarise information
- Read/send emails
- Prepare summary documents
- Run a campaign
- Network with other stakeholders



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Go to meetings and participate in discussions.



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Fill out survey forms, take proposals back back to groups.



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Read and review policy documents
React to proposed policy and practices



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Make media statements to support or oppose proposals.



Media Alert

Attention all media outlets

Surfrider Foundation

Date:

Headline:

Story:

Name of group

Contact in group

Phone number

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B. Providing research information for decision-making

Role –

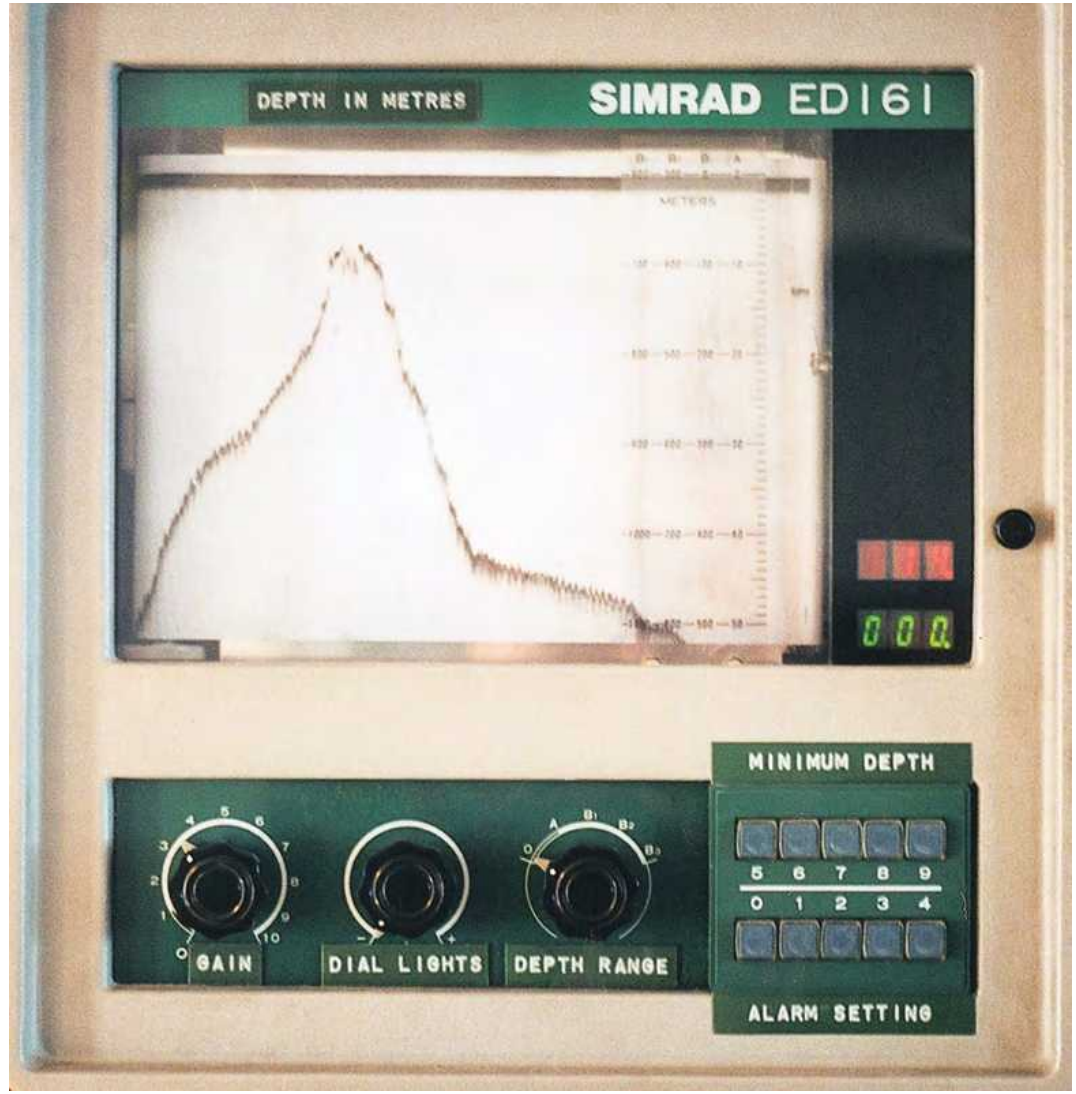
Provide general mapping of the area (using charts, satellite images and aerial photography).



Kerry Kitzelman

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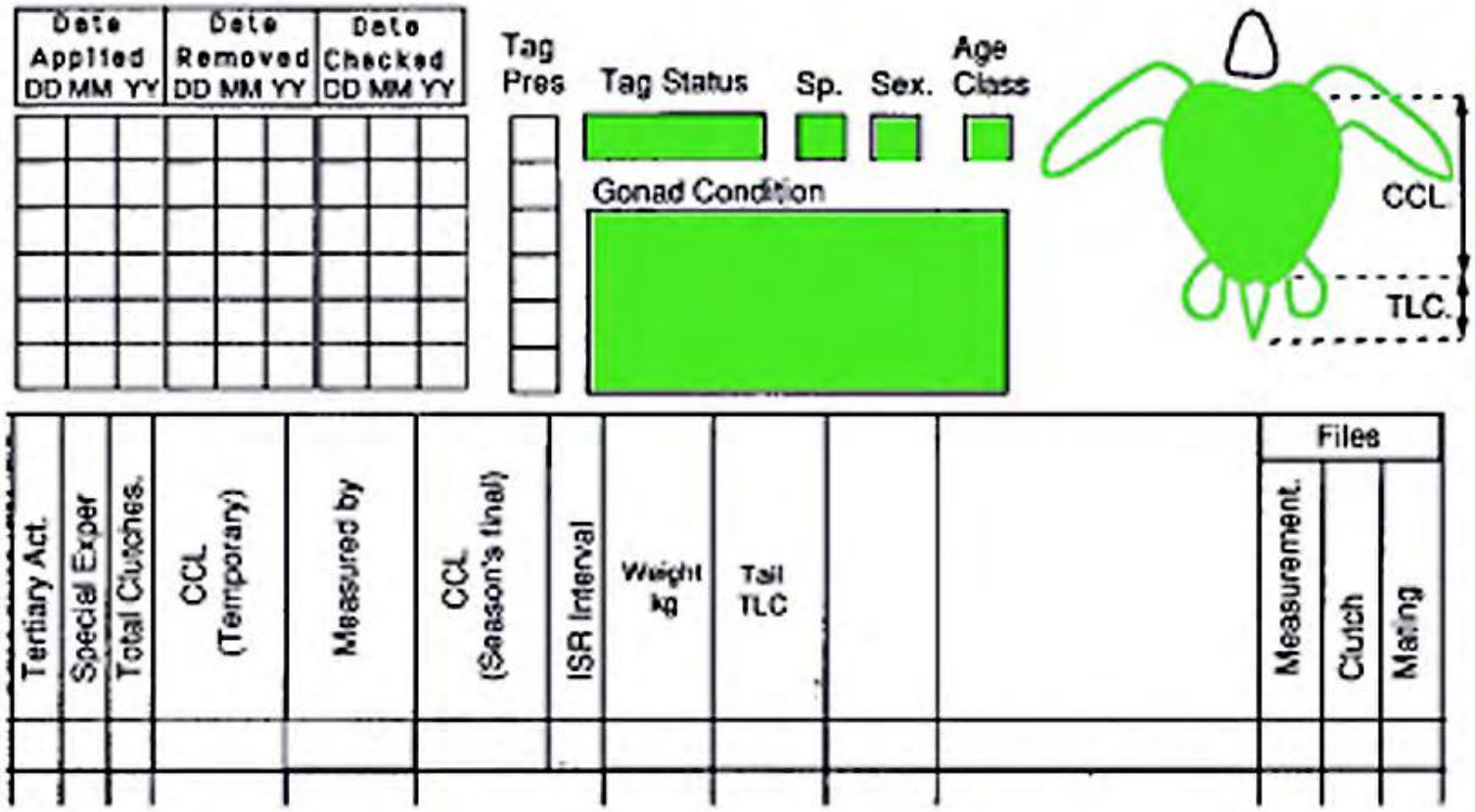
Role - Use underwater scuba (quadrats and transects, underwater video) and boats (echosounders, sonar, bottom grabs,drop video).



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Role - Conduct specific surveys of certain species (eg keystone, threatened and indicator species).



Qld NP&WLS

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Role – survey water quality and levels of pollutants (using electronic and chemical tests).



Qld Government

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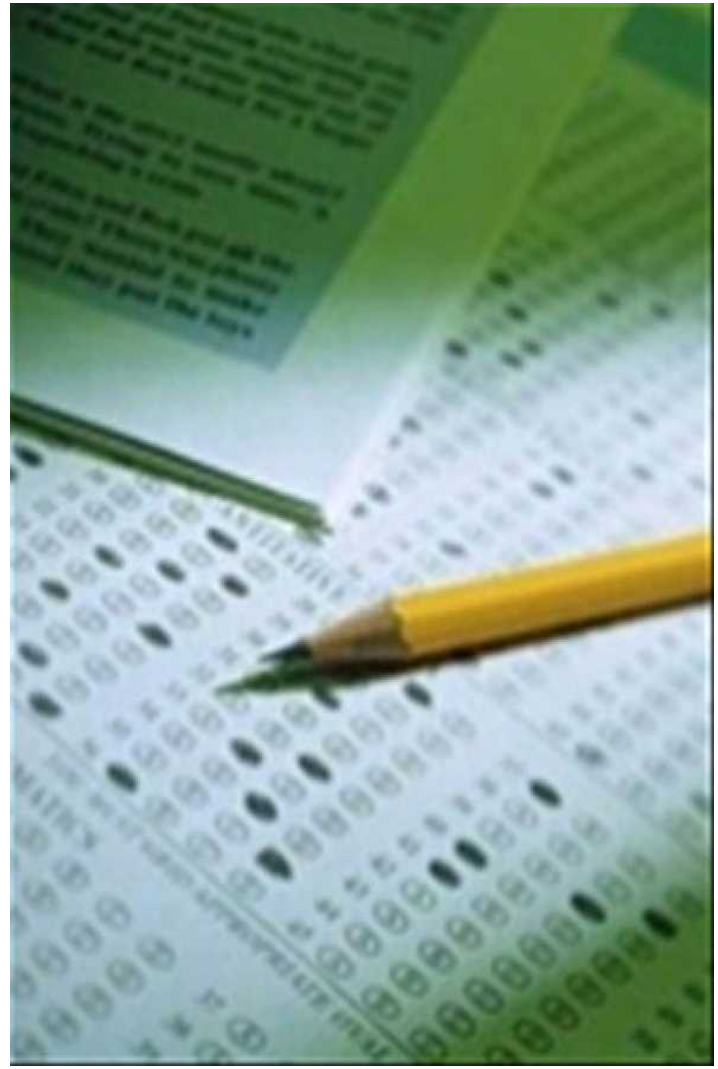
Role - conduct tests to establish toxic levels, so regulations on discharges can be developed (using live experiments);



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Role – conduct social and economic surveys to identify different human uses, and economic and cultural values (using interviews and questionnaires);



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Role - provide data storage and analysis of information (using computer databases such as Geographic Information Systems GIS).

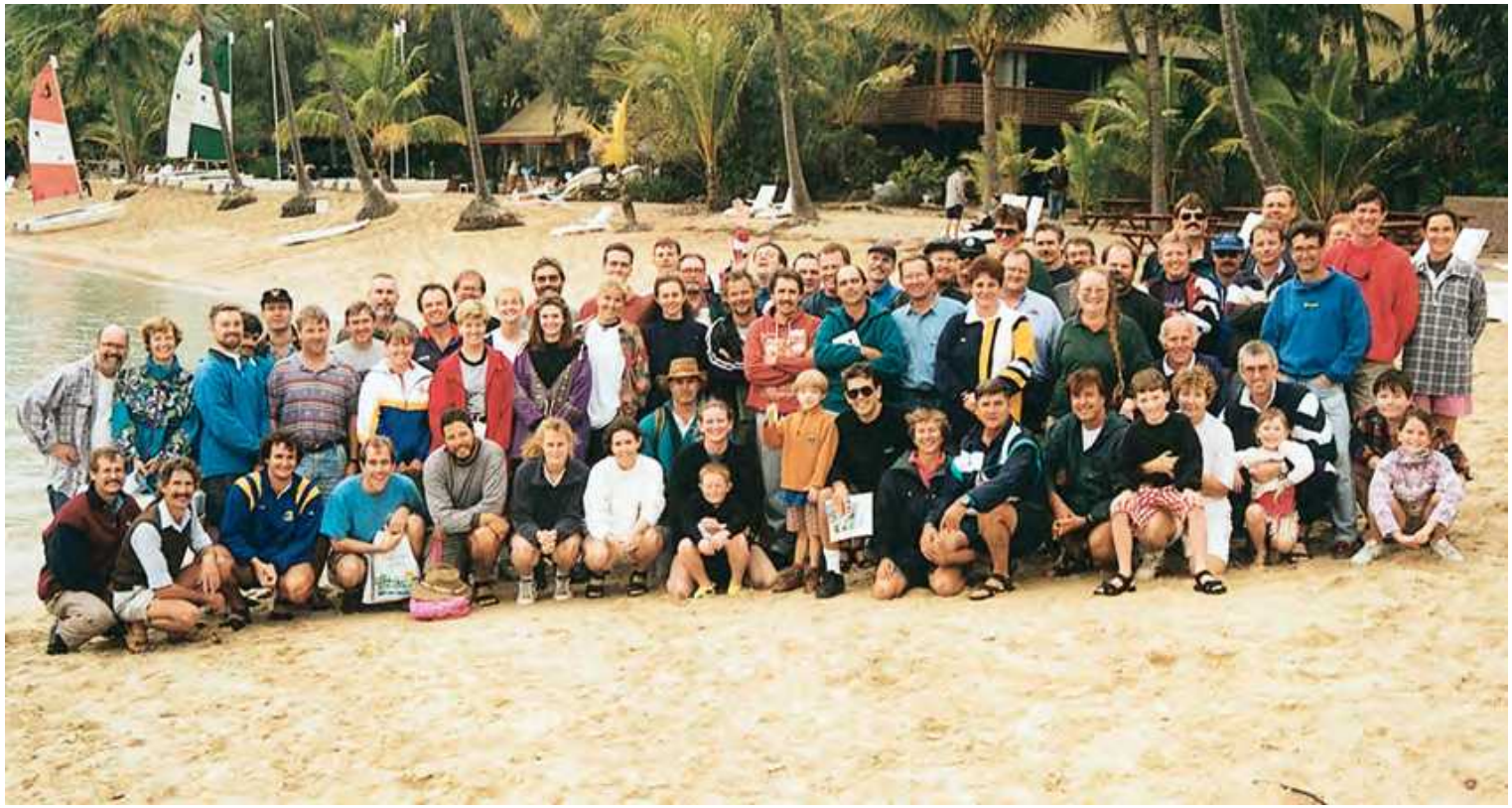


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C. Education to inform users and the wider community

Role – provide education networking opportunities.



Marine Teachers conference – Mackay circa 1997 Bob Moffatt

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Role - Teaching community based marine environmental programs, such as Waterwatch.



Mick O'Connor

© Wet Paper Publications

Role

Campaigning through
rallys and TV media shows.



Surfrider foundation

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Role - Media and social media involvement - key board warriors.

Type of social media	Corporate function					
	R&D	Marketing	Customer service	Sales	HR	Organisation
Blogs	◔	◑	◔			
Business networks					●	◔
Collaborative projects	●					
Enterprise social networks	◕				◑	●
Forums	◑	◔	●			
Microblogs		◕	◔		◔	
Photo sharing		◑				
Products/services review	◔	◑		●		
Social bookmarking		◑				
Social gaming		◑				
Social networks	◔	●	◑		◔	◔
Video sharing		●	◔			
Virtual worlds	◔	◕		◔		

Importance: (empty) none or almost none; ◔ low; ◑ medium; ◕ high; ● very high

By Aichner, T. and Jacob, F. - Aichner, T. and Jacob, F. (March 2015). "Measuring the Degree of Corporate Social Media Use". International Journal of Market Research 57 (2): 257–275., CC BY-SA 4.0, https://commons.wikimedia.org/w/index.php?curid=42779433

Facebook, Inc.



Mark Zuckerberg's profile (viewed from the login page)

Type of business	Public
Type of site	Social networking service
Available in	Multilingual (140)
Traded as	NASDAQ: FB (Class A) NASDAQ-100 component S&P 100 component S&P 500 component
Founded	February 4, 2004; 14 years ago

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Role - Becoming involved in politics – joining/supporting a political party and election campaigning.



Murray Waite

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Questions

1. Define the term stakeholder as it applies to the use and management of marine ecosystems.

2. Using the three stakeholder roles below, give examples of the roles they would play in the use and management of marine ecosystems.

Role list:

A. Interacting with planning agencies

B. Providing research information for decision-making processes, and

C. Education to inform users and the wider community.



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Reference

https://classroom.oceanteacher.org/pluginfile.php/3497/mod_resource/content/0/Pomeroy_Douvere_Stakeholder_Participation_MSP_2008.pdf



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T063 Stakeholder value systems



Bob Moffatt

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Syllabus statement

At the end of this topic you should be able to ...

appreciate

the specific value systems that identified stakeholders use (i.e. ecocentric, technocentric, anthropogenic)





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Appreciate

recognise or make a judgment about the value or worth of something; understand fully; grasp the full implications of



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Objective

Complete a stakeholder value system table that defines three types of value systems, list the types of arguments you would hear, and indicate if you appreciate the value system or not.

Value system	Definition	Implications when hearing people speek at stakeholder meetings.	Agree or disagree
Ecocentric			
Technocentric			
Anthropogenic			



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Example

Value system	Definition	Implications when hearing people speak at stakeholder meetings.	Agree or disagree
Ecocentric	This is a value system that integrates social, spiritual and environmental dimensions; places nature as central to humanity; encourages self-restraint in human behaviour as a means for solving environmental problems; prioritises 'bio rights'	You will hear arguments such as the rights of endangered species or unique landscapes to remain untouched. You will hear arguments that non-human organisms and the natural environment as a whole deserve consideration when appraising the morality of political, economic, and social policies.	✗ ✓
Technocentric	This is a value system that is centered on technology and its ability to control and protect the environment. Technocentrics have absolute faith in technology and industry and firmly believe that humans have control over nature.	You will hear arguments that environmental problems exist, but do not accept these problems can be solved by a reduction in industry. Their arguments are based on problems being solved using science and technology and in scientific research.	✗ ✓
Anthropogenic	Anthropocentrism is the belief that human beings are the most important entity in the universe. Anthropocentrism interprets or regards the world in terms of human values and experiences.	You will hear arguments that encourage sustainable management of resources through taxes, regulations and legislation as a means for solving environmental problems.	✗ ✓

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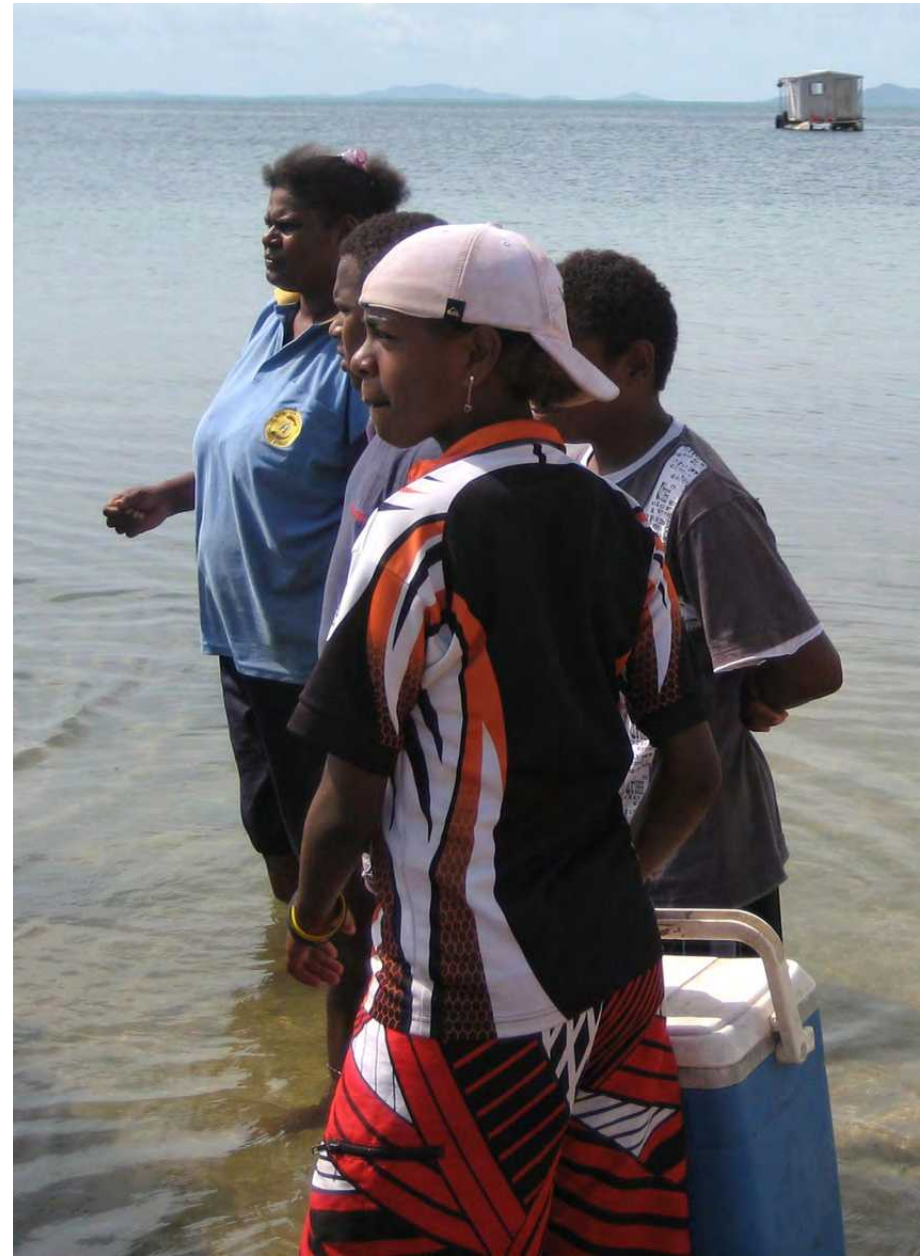
Ecocentric

This is a value system that

- integrates social, spiritual and environmental dimensions;
- places nature as central to humanity;
- encourages self-restraint in human behaviour as a means for solving environmental problems;
- prioritises ‘bio rights’.

Reference

https://en.wikipedia.org/wiki/Ecocentrism



Marine Qld

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You will hear arguments such as the rights of endangered species or unique landscapes to remain untouched.



Viewfinder

© Wet Paper Publications

You will hear arguments that non-human organisms and the natural environment as a whole, deserve consideration when appraising the morality of political, economic, and social policies.



Viewfinder

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Technocentric

This is a value system that is centered on technology and its ability to control and protect the environment.

Reference

https://en.wikipedia.org/wiki/Technocentrism



Viewfinder

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Technocentrics have absolute faith in technology and industry and firmly believe that humans have control over nature.

A turbine produces electricity – vital to farming and manufacturing.



By Siemens Pressebild - http://www.siemens.com/index.jsp?sdc_p=cfi1075924l0mno1130262ps5uz3&sdc_bcpath=1327899.s_5%2C%3A1176453.s_5%2C&sdc_sid=31880989447&, CC BY-SA 3.0, https://commons.wikimedia.org/w/index.php?curid=444984

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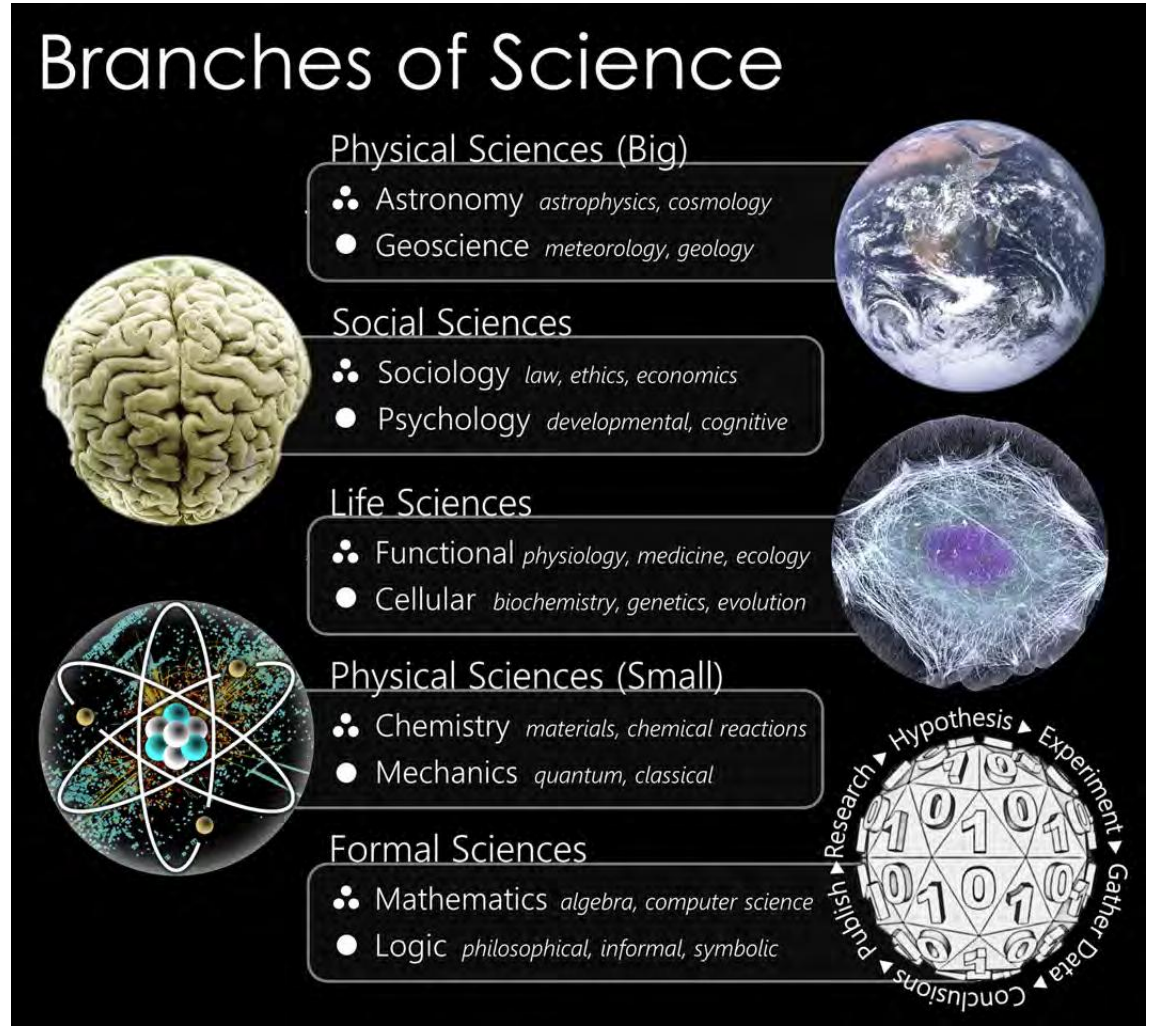
You will hear arguments that environmental problems exist, but do not accept these problems can be solved by a reduction in industry.



Bob Moffatt

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Their arguments are based on problems being solved using science and technology and in scientific research.



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Anthropogenic

Anthropocentrism is the belief that human beings are the most important entity in the universe.



Viewfinder

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You will hear arguments that encourage sustainable management of resources through taxes, regulations and legislation as a means for solving environmental problems.



Viewfinder

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Do you appreciate

the specific value systems that identified stakeholders use (i.e. ecocentric, technocentric, anthropogenic)?

Agree or disagree?



Viewfinder

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Question

Complete the table below to define three types of value systems, list the types of arguments you would hear, and indicate if you appreciate the value system or not.

Value system	Definition	Implications when hearing people speek at stakeholder meetings.	Agree or disagree
Ecocentric			
Technocentric			
Anthropogenic			

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T064 Marine ecosystem issues



Bob Moffatt

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Syllabus statement

At the end of this topic you should be able to ...

Recognise

the issues affecting a selected marine ecosystem.





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Recognise

- identify or recall particular features of information from knowledge;
- identify that an item, characteristic or quality exists;
- perceive as existing or true;
- be aware of or acknowledge





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Objectives

1. List five issues affecting marine ecosystem, using acid sulphate soils as an example.

2. Illustrate your answer with a development consequences chart for mangroves using acid sulphate soils as an example.



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Issues affecting marine ecosystems

1. Over exploitation - recreational and commercial
2. Pollution
3. Habitat destruction and fragmentation
4. Non-native species invasions
5. Global climate change



References

http://www.marbef.org/wiki/Over_exploitation
http://www.marbef.org/wiki/Pollution
http://www.marbef.org/wiki/Habitat_destruction_and_fragmentation
http://www.marbef.org/wiki/Non-native_species_invasions
http://www.marbef.org/wiki/Effects_of_global_climate_change_on_European_marine_biodiversity

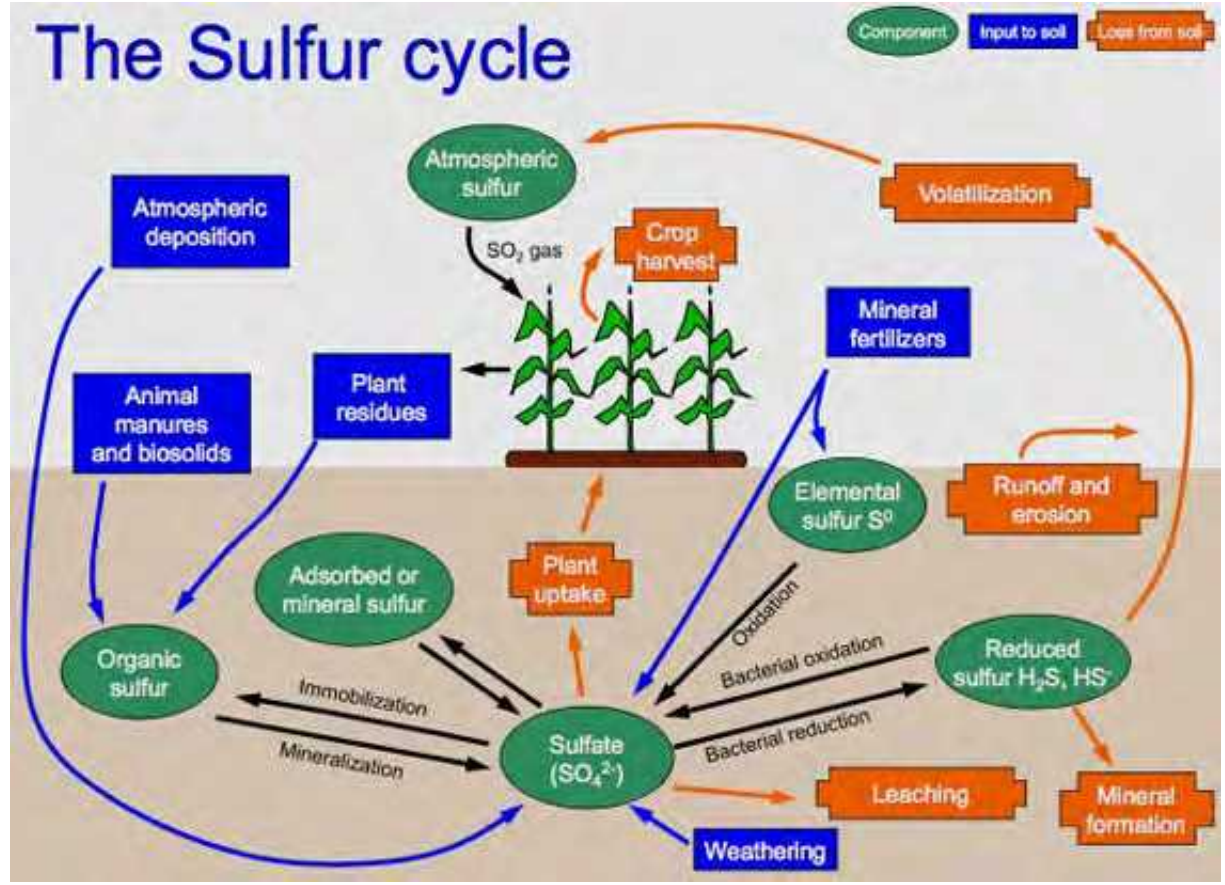
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Acid sulfate soil example

Habitat destruction and fragmentation

Acid sulfate soils (ASS) are the common name given to soils containing iron sulfides (principally iron pyrite) or products of the oxidation of sulfides.

These soils form when sea or brackish water mixes with sediments containing organic matter, and are part of the world's natural sulfur cycle.



By Welcome1To1The1Jungle at English Wikipedia, CC BY 3.0, https://commons.wikimedia.org/w/index.php?curid=48498088

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During the formation processes, sulfate in seawater was reduced by bacteria to iron sulfide (commonly known as iron pyrite) in waterlogged, saline sediments where there was a supply of easily decomposed organic matter, eg mangrove swamps and saltwater marshes.

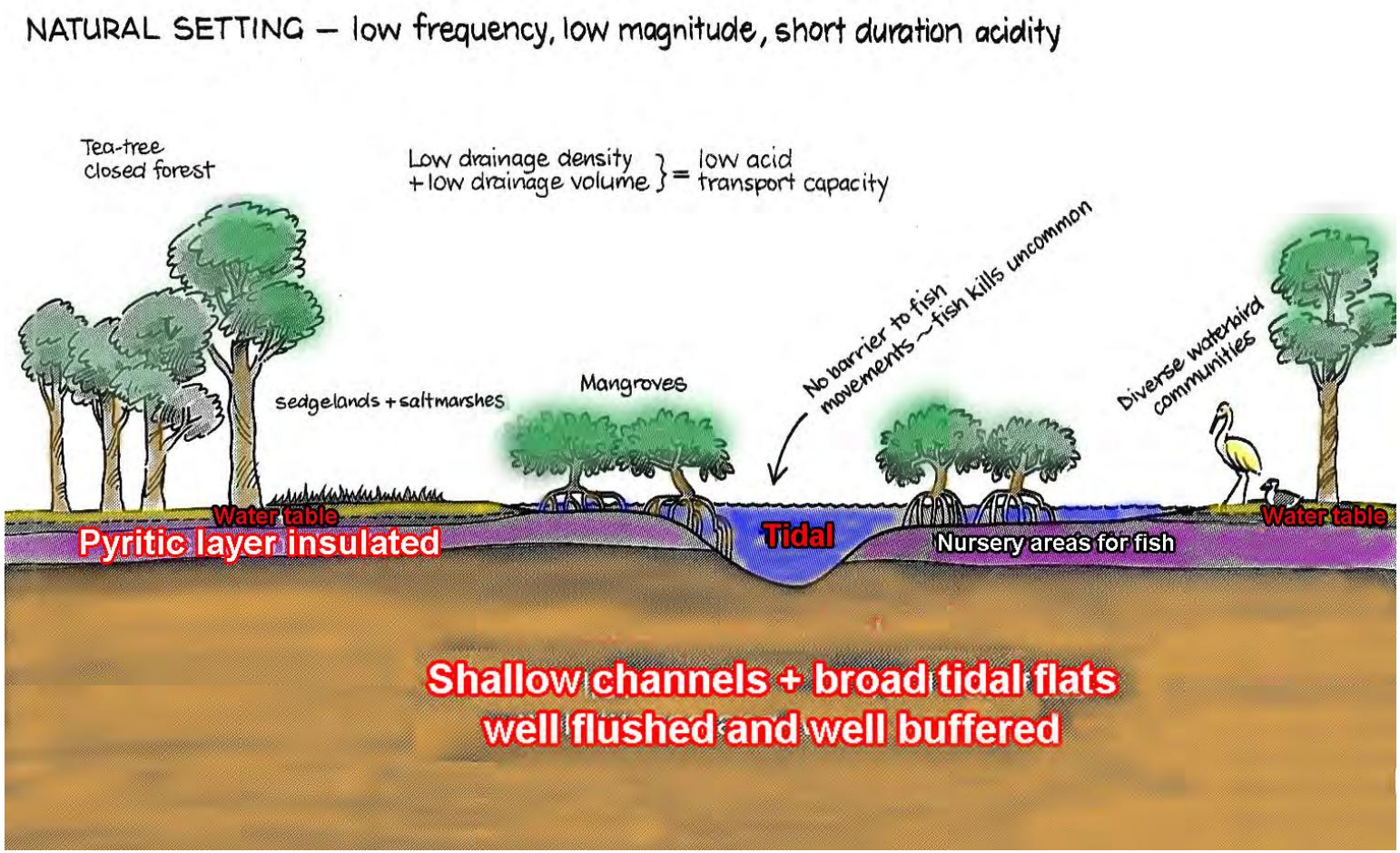


Acid sulphate soils exposed in mangrove area

By R.J.Oosterbaan.Original uploader was R.Oosterbaan at nl.wikipedia - Transferred from nl.wikipedia(Original text : eigen foto), Public Domain, https://commons.wikimedia.org/w/index.php?curid=6993629

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The pyrite is stable under anaerobic conditions and these sediments which have potential to produce sulfuric acid present in an anaerobic environment are known as potential acid sulfate soils.



Qld fisheries

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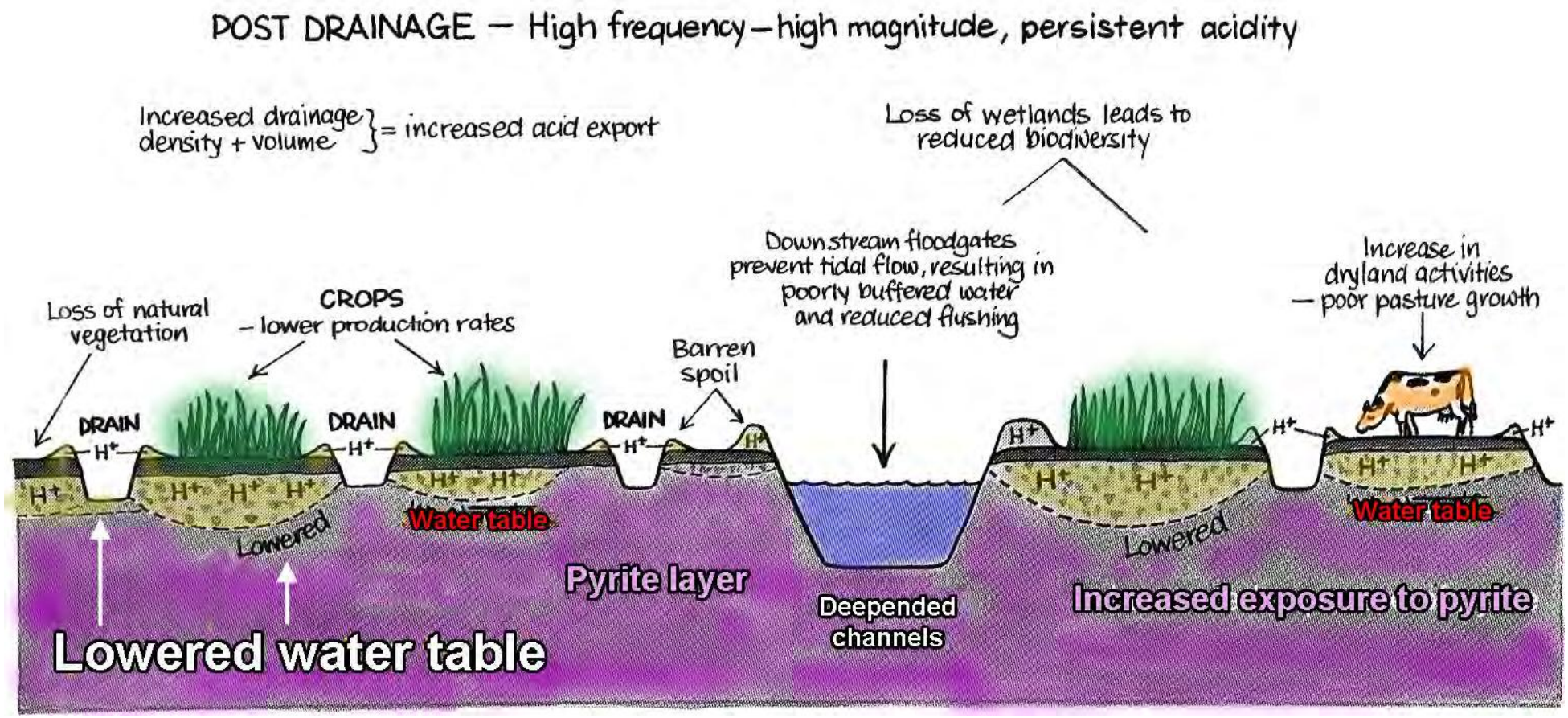
Exposure of the pyrite to air by agricultural activities, excavation, drainage, dredging, stockpiling of sediment or drought, results in oxidation of the sulfide to form sulfuric acid, often with the release of toxic aluminium when the alumino-silicate clay lattice of soil is dissolved.



Dredge in canal
Bob Moffatt

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The post drainage effects of these activities, result in high frequency persistent acidity leading to:
- reduced biodiversity
- reduced crop production and pasture growth
- threats to building construction in urban development



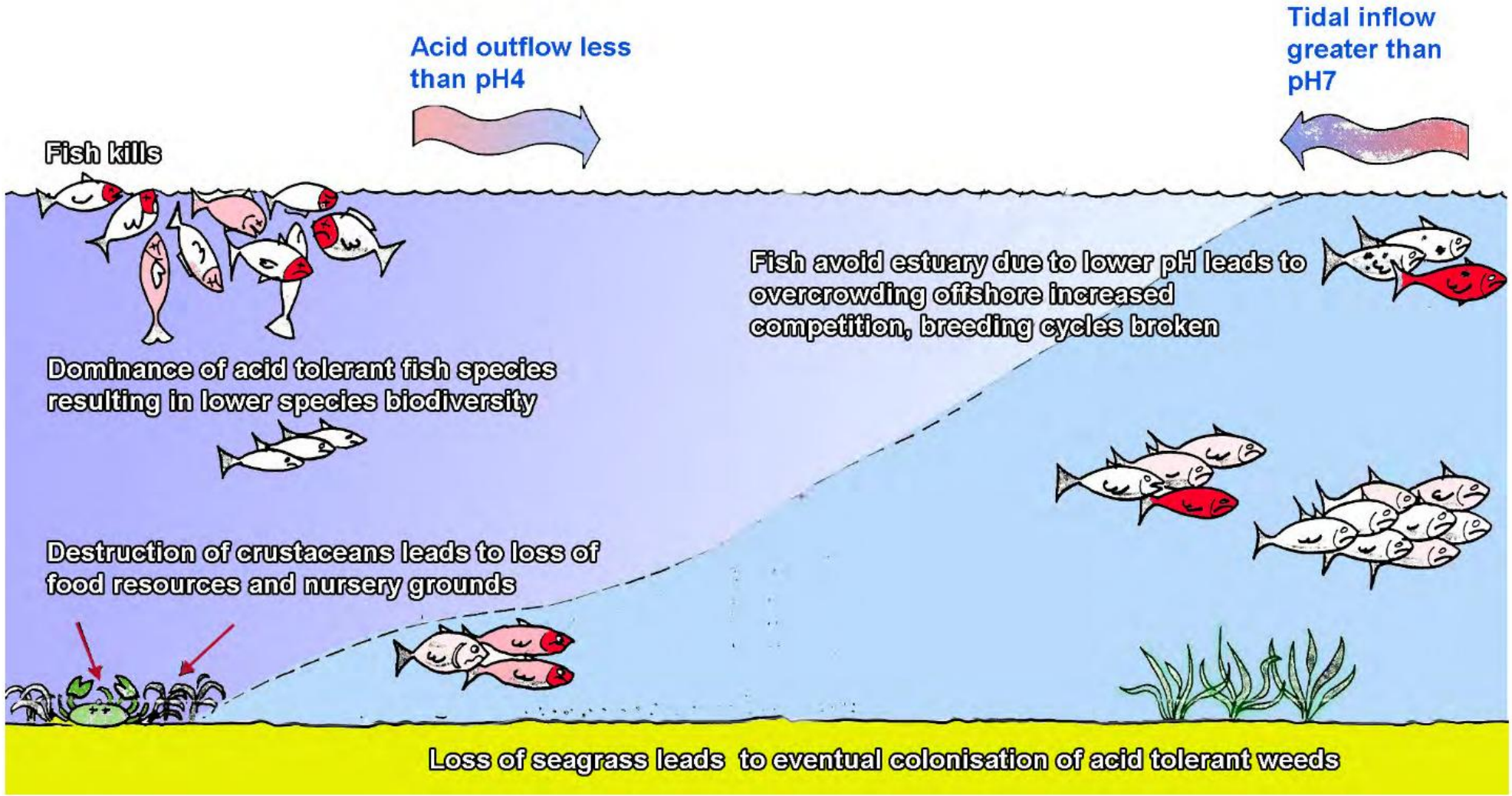
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Effects on aquatic organisms include:

- Fish kills.
- Dominance of acid tolerant fish species resulting in lower species biodiversity.
- Destruction of crustaceans leads to loss of food resources and nursery grounds
- Loss of seagrass leads to eventual colonisation of acid tolerant weeds.
- Fish avoid estuary due to lower pH leads to overcrowding offshore increased competition, breeding cycles broken.



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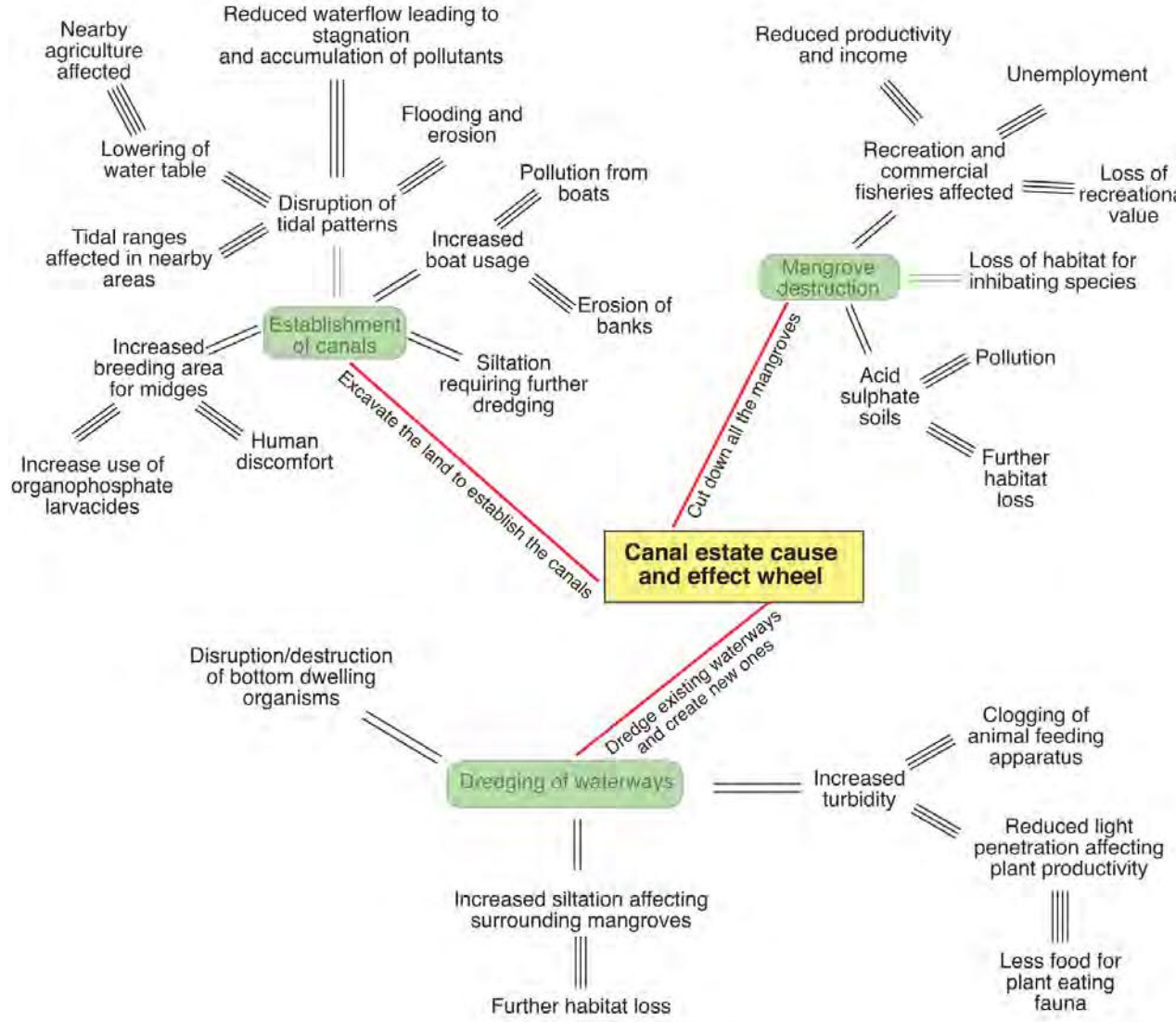


Qld fisheries

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Other issues

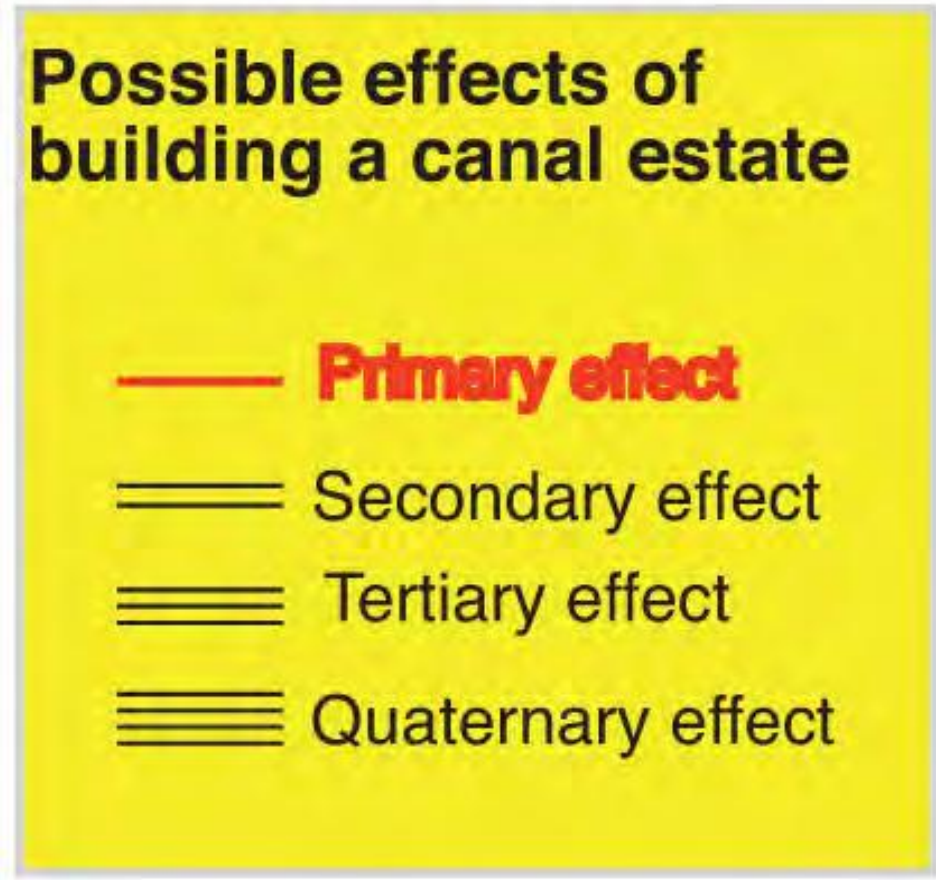
Other issues affecting this selected marine ecosystem can be summarised in a chart which shows four possible effects on the ecosystem, where a canal development is proposed.



From Mangroves in focus by Claridge and Burnett

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The chart is based on primary, secondary and tertiary consequences with a four line key.



From Mangroves in focus by Claridge and Burnett

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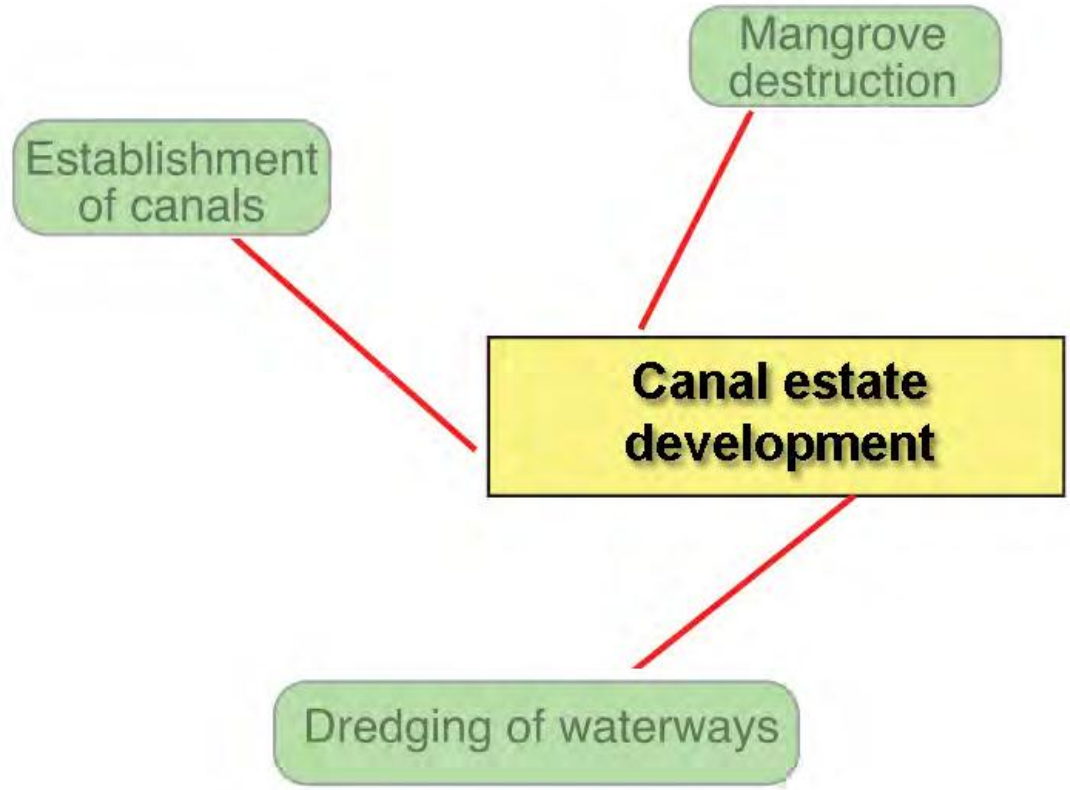
PROPOSED DEVELOPMENT

To develop the canal system, three things need to happen:

a. Cut down the mangroves

b. Establish the canals

c. Dredge existing waterways



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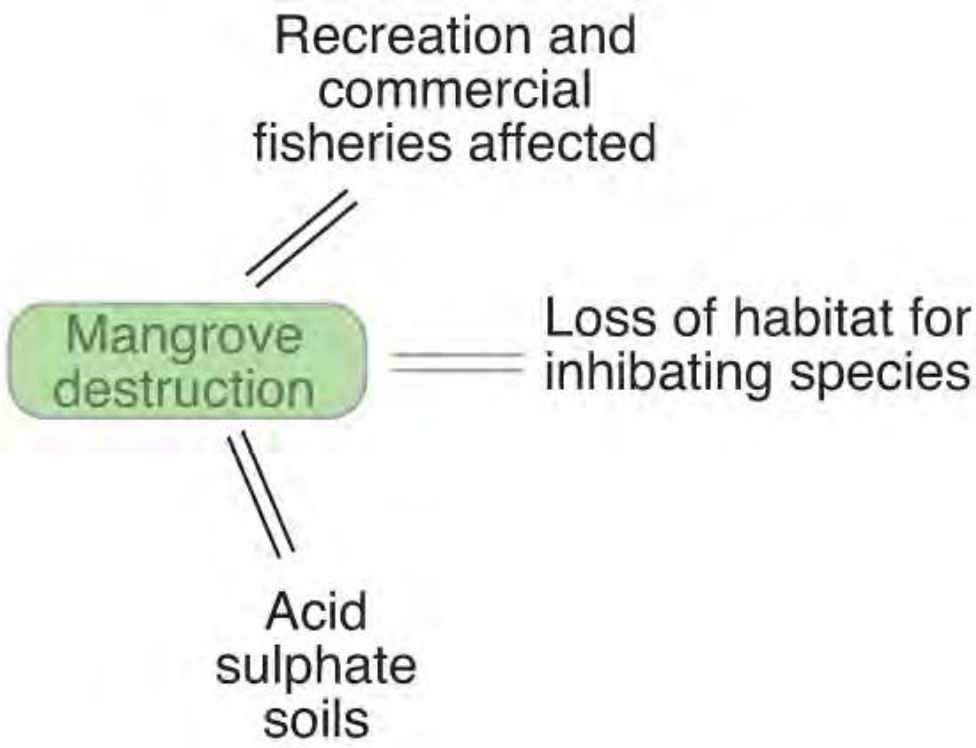
Primary effects of this type of development are:
- Mangroves are destroyed
- Land gets excavated
- Benthos gets disturbed



Real estate.com

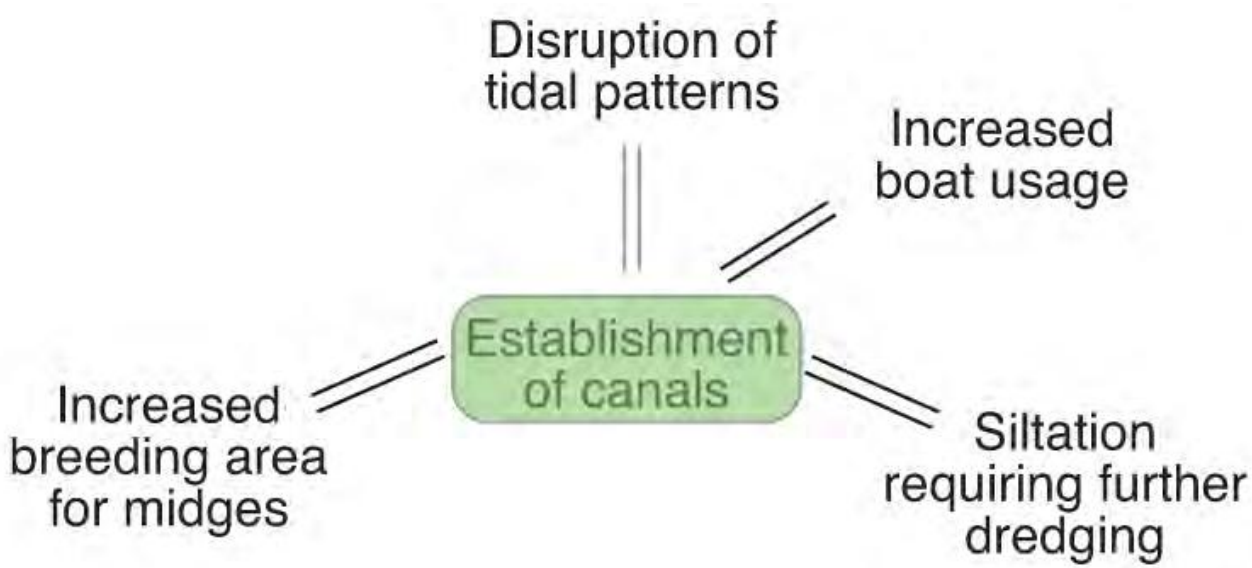
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Secondary effects



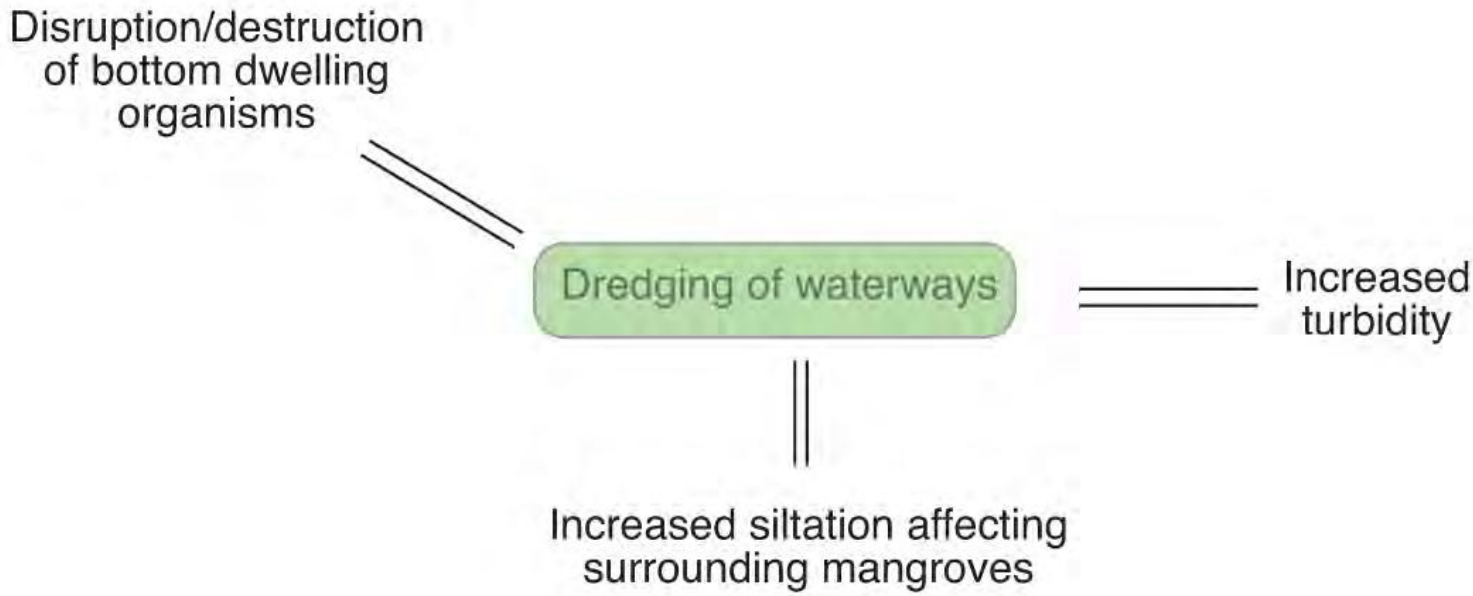
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Land excavation



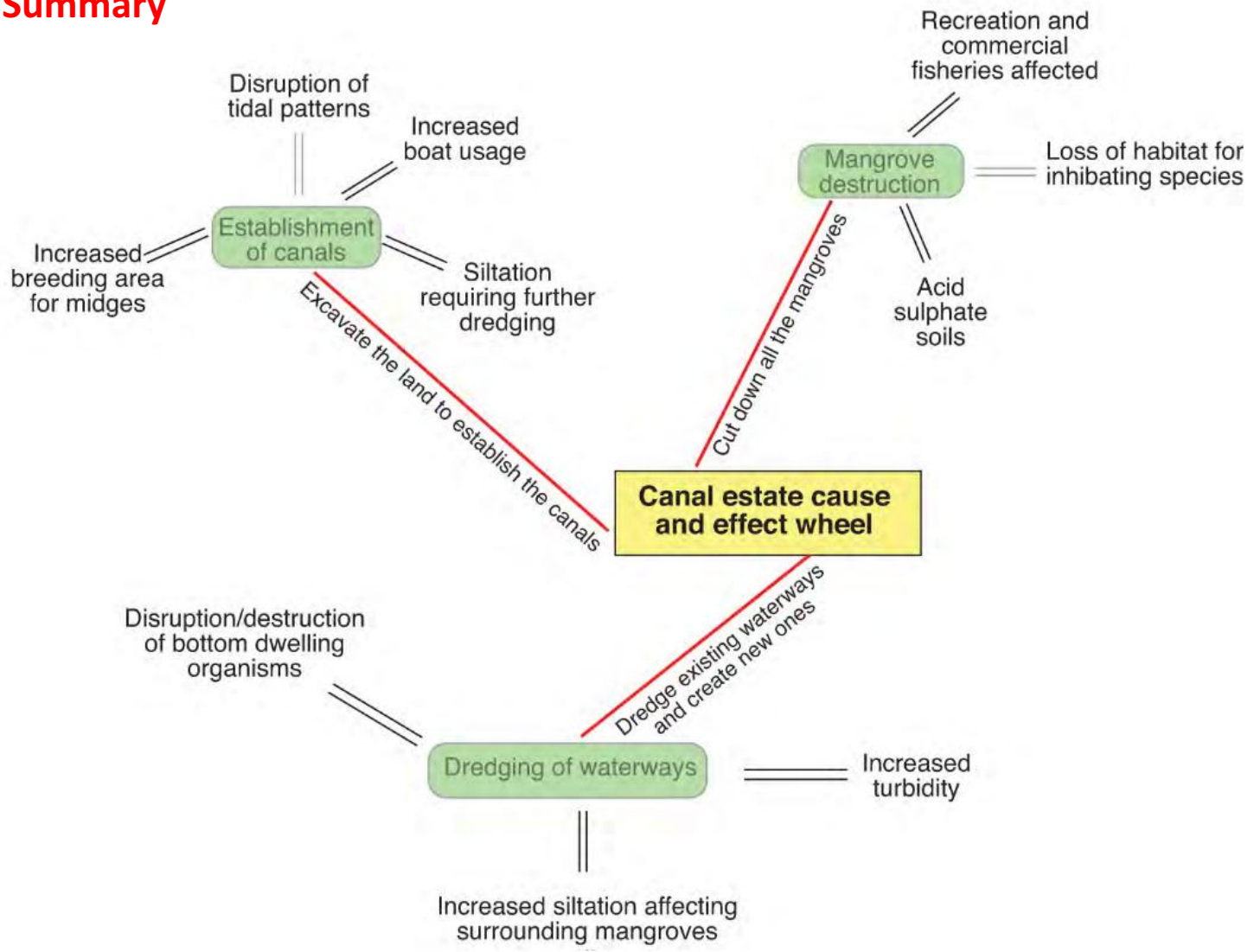
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Benthos disturbance



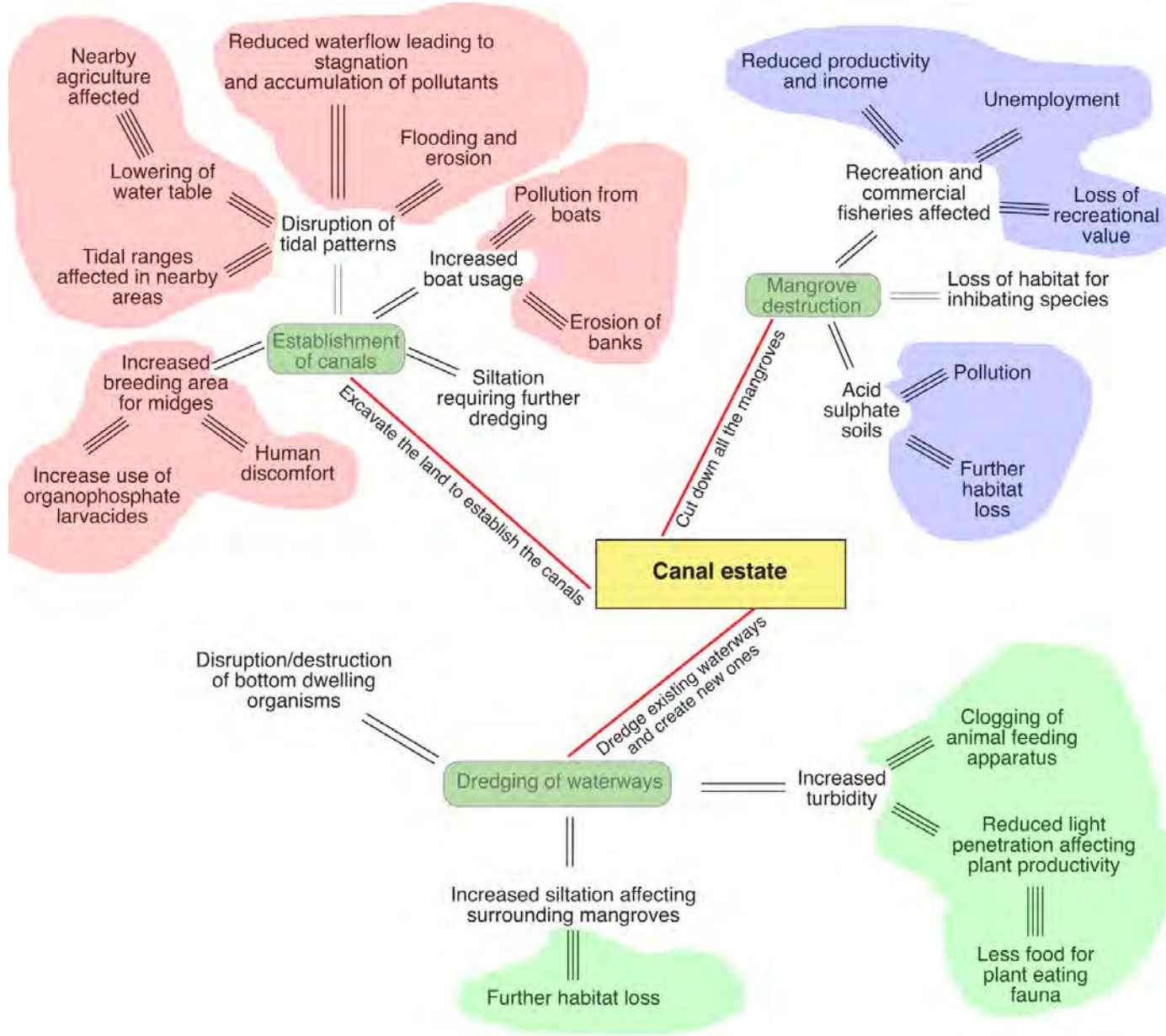
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Summary



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Tertiary and quaternary effects



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So, the final result is a great place to live in a dead and fractured environment.



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– or is it?

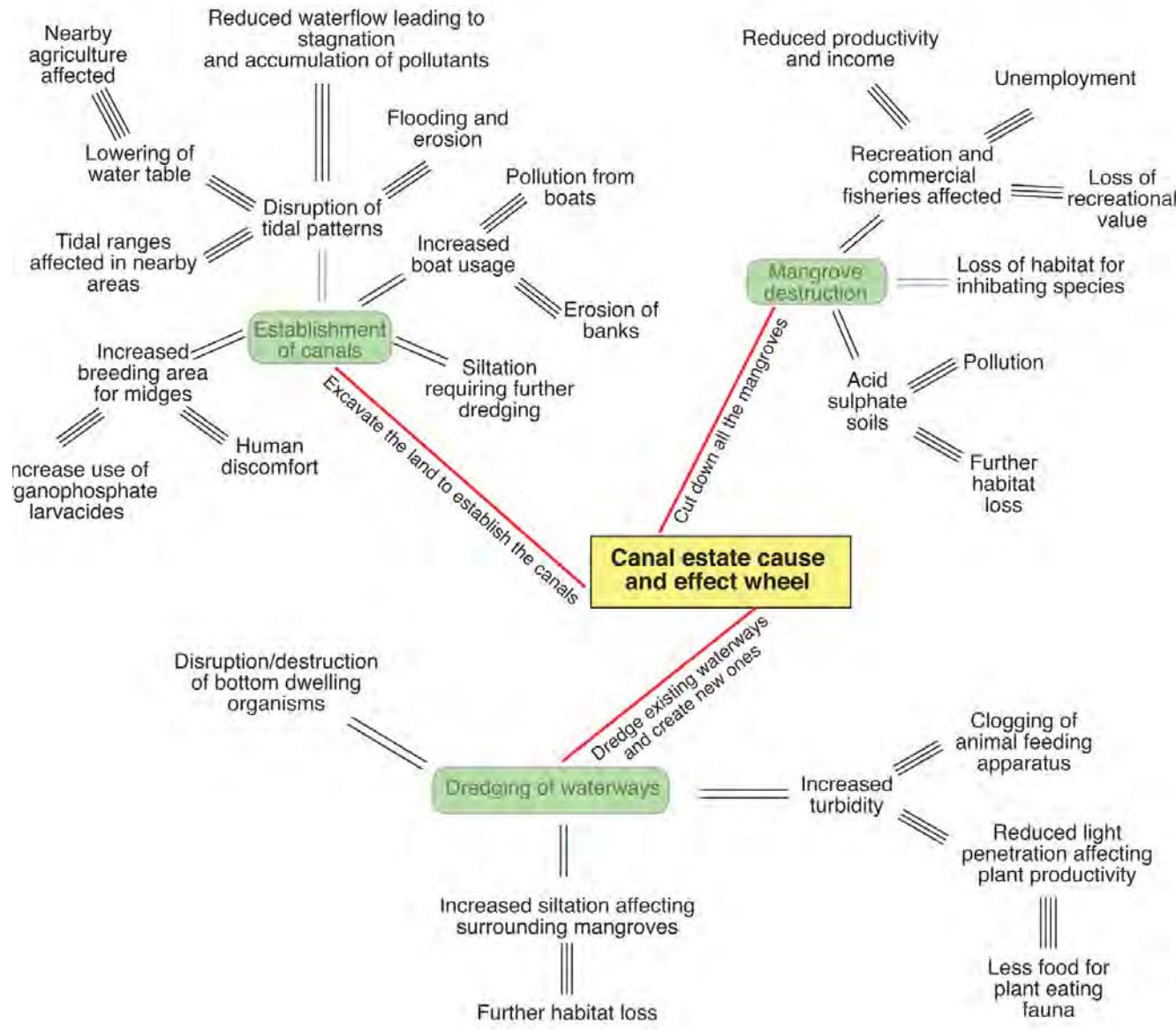


Realestate.com

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Question

Use this figure to complete the table on the next page.



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Proposed development	Primary effect	Secondary effects	Tertiary effects
Cut down the mangroves			
Establish the canals			
Dredge existing waterways			

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Proposed development	Primary effect	Secondary effects	Tertiary effects
Cut down the mangroves	Mangrove are destroyed	Recreational and commercial fisheries are affected There is a loss of habitat for existing species Acid sulphate soils are exposed	Loss of recreational and commercial fisheries means reduced productivity and income and unemployment. Loss of habitat fractures the existing ecosystem leading to loss of biodiversity. Acid sulphate soils leads to lowering of the water table. Further habitat loss, possible building foundation issues with acid corrosion and pollution.
Establish the canals	Land gets excavated	Disruption of tidal patterns Increased boat usage Siltation requiring further dredging Increased breeding areas for midges	Reduced water flow leading to stagnation and accumulation of pollutants. Flooding, bank erosion and siltation. Pollution from boats Human discomfort from more midges. Increased spraying to control midges. Tidal ranges change for nearby areas cam affect primary production eg aquaculture farms.
Dredge existing waterways	Benthos gets disturbed	Disruption or destruction of bottom dwelling organisms Increased siltation around mangroves Increased turbidity	Clogging of filter feeders mouth parts. Reduced light penetration affecting plant productivity. Less food for herbivorous animals Loss of biodiversity.

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T065 Ecosystem health terms



Bob Moffatt

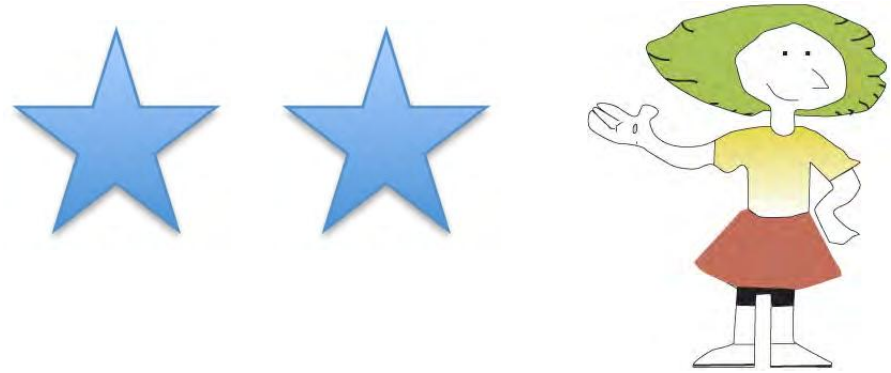
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Syllabus statement

At the end of this topic you should be able to ...

Apply

the terms ecosystem resilience, disturbance and recovery as indicators of ‘health’ of marine environments to a chosen case study.



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Apply

use knowledge and understanding in response to a given situation or circumstance; carry out or use a procedure in a given or particular situation





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Definitions

Ecosystem resilience (syllabus)

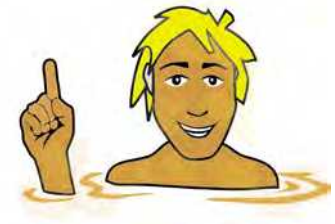
the capacity of an ecosystem to recover from a disturbance or withstand ongoing pressures.

Ecosystem disturbance (syllabus)

a temporary change in environmental conditions that alters physical structures or arrangements of biotic and abiotic elements within an ecosystem; can also occur over larger temporal scales and affect diversity; can be natural or anthropogenic.

Ecosystem recovery (syllabus)

the return of a damaged ecological system and associated ecosystem services to a stable state.



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Objective

To show how the Great Barrier Reef report 2014 uses resilience, disturbance and recovery to report on the health of the reef.



http://elibrary.gbrmpa.gov.au/jspui/handle/11017/2855

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In this report the chairman makes the statement that:

"Even with the recent management initiatives to reduce threats and improve resilience, the overall outlook for the Great Barrier Reef is poor and getting worse".

Hon. Greg Hunt MP
Minister for the Environment
Parliament House
CANBERRA

Australian Government
Great Barrier Reef Marine Park Authority

Dear Minister

I am pleased to provide the Great Barrier Reef Outlook Report 2014 to you as Minister for the Environment and through you to the Australian Parliament and the people of Australia.

The Great Barrier Reef Outlook Report 2014 has been prepared by the Great Barrier Reef Marine Park Authority based on the best available information. It fulfils the requirements of Section 54 of the Great Barrier Reef Marine Park Act 1975. The report includes nine assessments covering biodiversity, ecosystem health, heritage values, commercial and non-commercial use, factors influencing the Reef's values, existing protection and management, resilience, risks and the long-term outlook for both the ecosystem and heritage values. The contents of the report were independently peer reviewed.

The specific inclusion of 'heritage' is new and responds to both revised requirements of the Act and a World Heritage Committee request (36COM 7B.8) to include an explicit assessment of the Great Barrier Reef World Heritage Area's outstanding universal value in subsequent Outlook Reports.

The legislation requires that an Outlook Report be prepared every five years. As in the first Outlook Report in 2009, this second report identifies that the Great Barrier Reef Region faces significant pressures ranging in scale from local to global. Since 2009, management initiatives and local actions have demonstrated positive outcomes and the Great Barrier Reef is retaining its outstanding universal value as a world heritage area. Nevertheless, extreme weather events, combined with the lag times required for the recovery of key habitats, species and ecosystem processes, have caused the continued deterioration of the overall health of the Great Barrier Reef. The accumulation of impacts, through time and over an increasing area, is reducing its ability to recover from disturbances, with implications for Reef-dependent communities and industries.

Terms

Even with the recent management initiatives to reduce threats and improve resilience, the overall outlook for the Great Barrier Reef is poor and getting worse. These findings will be best addressed through coordinated action across governments, industries and the community.

I commend this Outlook Report to you for tabling in both Houses of the Australian Parliament.

Yours sincerely

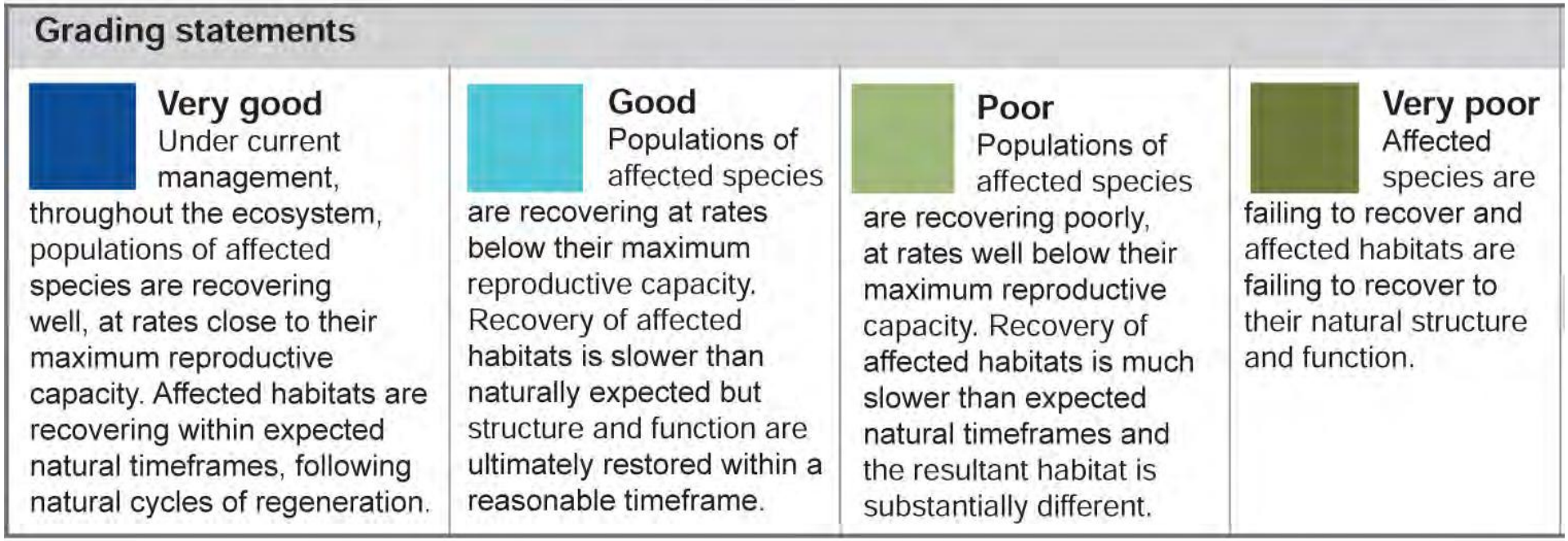
Health

Russell Reichelt
Chairman and Chief Executive Officer
Great Barrier Reef Marine Park Authority

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Resilience, the capacity of an ecosystem to recover from a disturbance or withstand ongoing pressures, is graded into 4 categories:

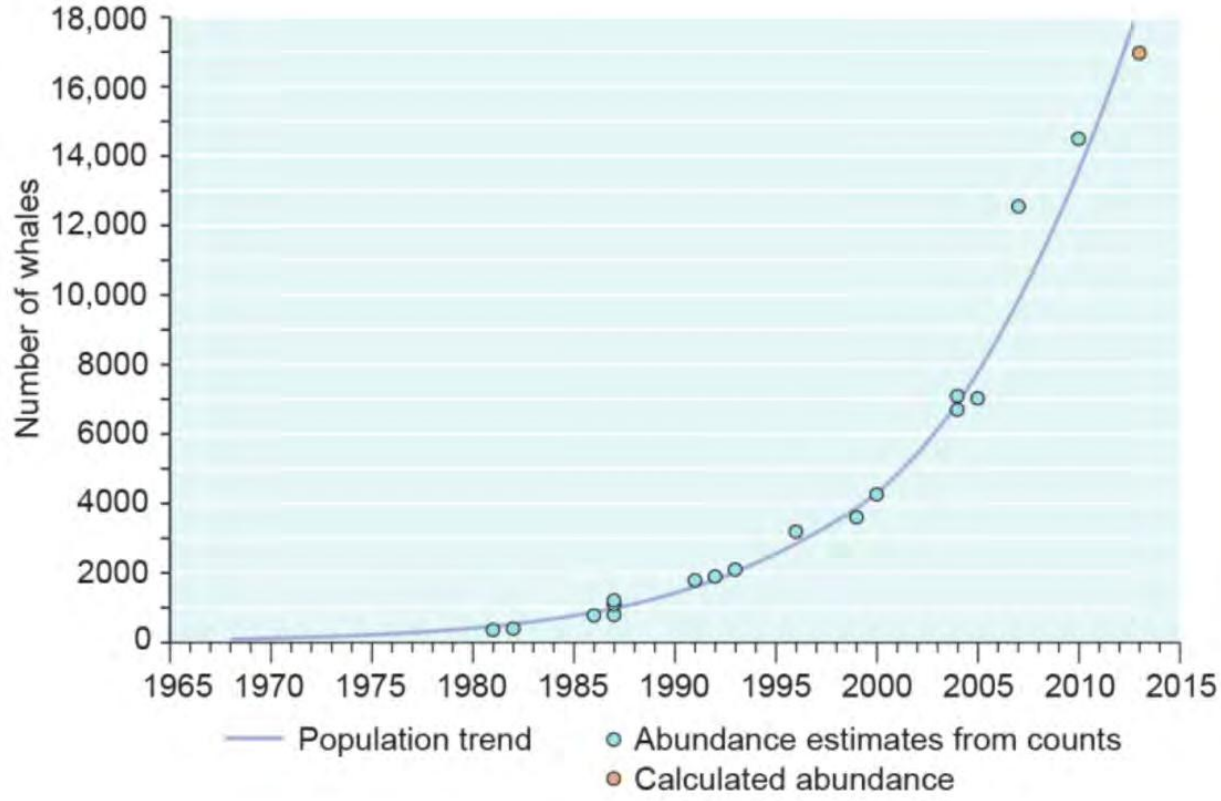


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Whales get a very good score because their reproductive rate is close to their maximum reproductive capacity.

Very good
Under current management, throughout the ecosystem, populations of affected species are recovering well, at rates close to their maximum reproductive capacity. Affected habitats are recovering within expected natural timeframes, following natural cycles of regeneration.



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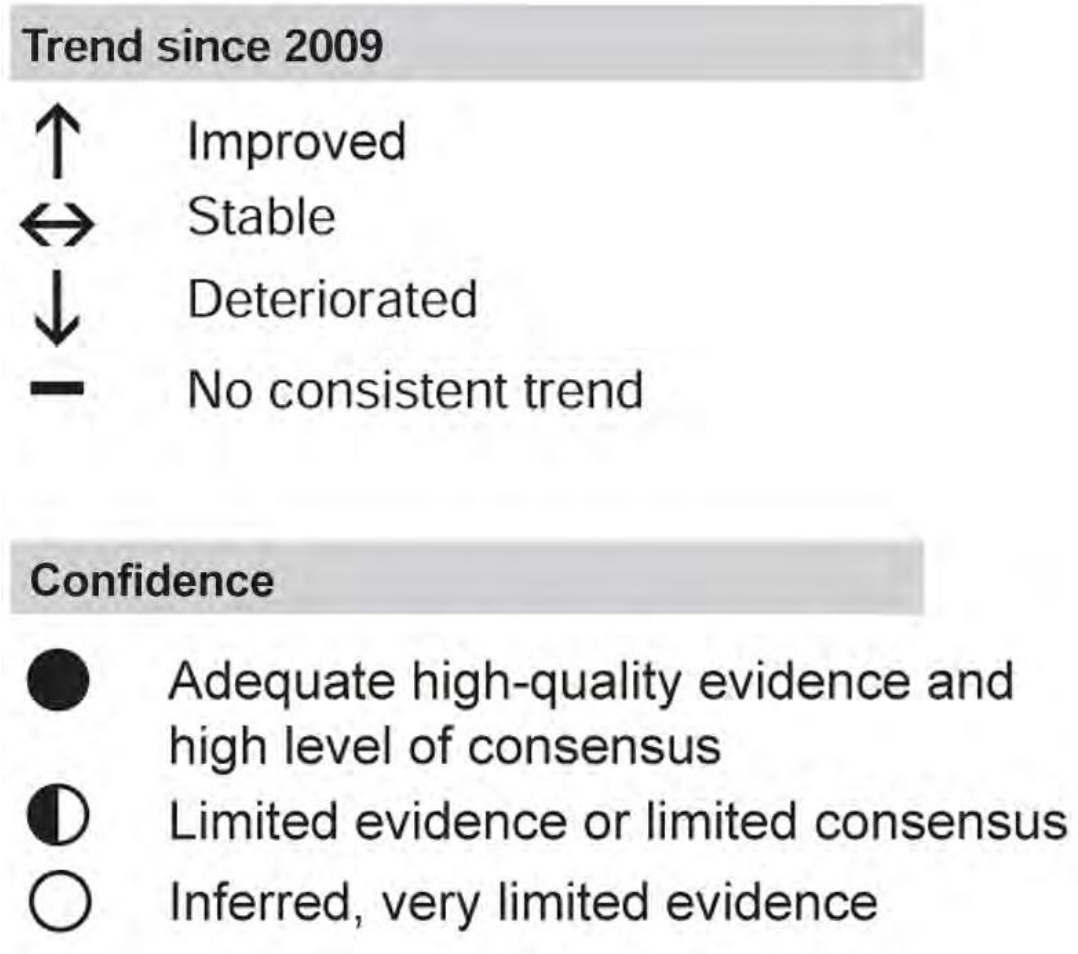
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Trends and confidence

Resilience is further applied to indicate trends and confidence in ratings.

Trends are either improved, stable, deteriorated or no consistency.

Confidence is either Adequate, limited or inferred.



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Resilience, trend and confidence is then tabulated.

2009 Grade	Current summary and assessment components	Assessment grade and trend				Confidence	
		Very good	Good	Poor	Very poor	Grade	Trend
	Humpback whales: Humpback whales continue to recover at their maximum population growth rate 50 years after whaling stopped.	↑				●	●

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Kerry Kitzelman

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The assessment on whales can then be compared with other ecosystem components.

2009 Grade	Current summary and assessment components	Assessment grade and trend				Confidence	
		Very good	Good	Poor	Very poor	Grade	Trend
	Recovery in the ecosystem: Some disturbed populations and habitats have demonstrated recovery after disturbance (for example lagoon floor, loggerhead turtles, humpback whales). For some species recovery is not evident (black teatfish, dugongs) and is dependent on the removal of all threats. Increasing frequency and extent of some threats are likely to continue to reduce the resilience of species and habitats in the Region.			↓			
	Coral reef habitats: Increases in frequency and severity of disturbances, such as cyclones, flooding, crown-of-thorns starfish outbreaks have reduced the capacity for coral reefs to recover since 2009. There is evidence of recovery at a local scale.			↓		●	◐
	Lagoon floor habitats: Ongoing management arrangements mean that some lagoon floor habitats previously at risk are continuing to recover from disturbances. There is little monitoring of lagoon floor condition or recovery.		↔			◐	◐
	Black teatfish: Based on recent modelling, populations of black teatfish in the Region are likely to be slowly recovering. Populations have recovered in Torres Strait.				↑	◐	◐
	Coral trout: Coral trout populations demonstrate a strong ability to recover and increased reproduction in zones closed to fishing disperses beyond those zones. There are emerging concerns about the overall condition of coral trout populations.		–			◐	◐
	Loggerhead turtles: Loggerhead turtle populations are recovering. There are comprehensive management arrangements in the Region, but some threats remain. Pressures from outside Australian waters are likely to influence their full recovery.			↑		●	●
	Urban coast dugongs: The urban coast dugong population has declined further since 2009, affected by the loss of seagrass from cyclones and flooding. Continued effective implementation of all management arrangements is required to reduce direct threats.				↓	●	◐
	Humpback whales: Humpback whales continue to recover at their maximum population growth rate 50 years after whaling stopped.	↑				●	●

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Disturbance

In the case of whales, whaling was the anthropogenic disturbance.



By Oswald Brierly - The painting is in the collection of the Art Gallery of New South Wales. http://www.artgallery.nsw.gov.au/collection/works/6294/, Public Domain, https://commons.wikimedia.org/w/index.php?curid=12663361

Remember

Disturbance - a temporary change in environmental conditions that alters physical structures or arrangements of biotic and abiotic elements within an ecosystem; can also occur over larger temporal scales and affect diversity; can be natural or anthropogenic.



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Disturbance to corals

The report (page 228) details:

- cyclone-induced waves
- crown of-thorns starfish outbreaks
- elevated sea surface temperatures
- freshwater inflow



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The magnitude of the impacts has been normalised between zero and one.

The higher the exposure number, the greater the exposure to the disturbances modelled.

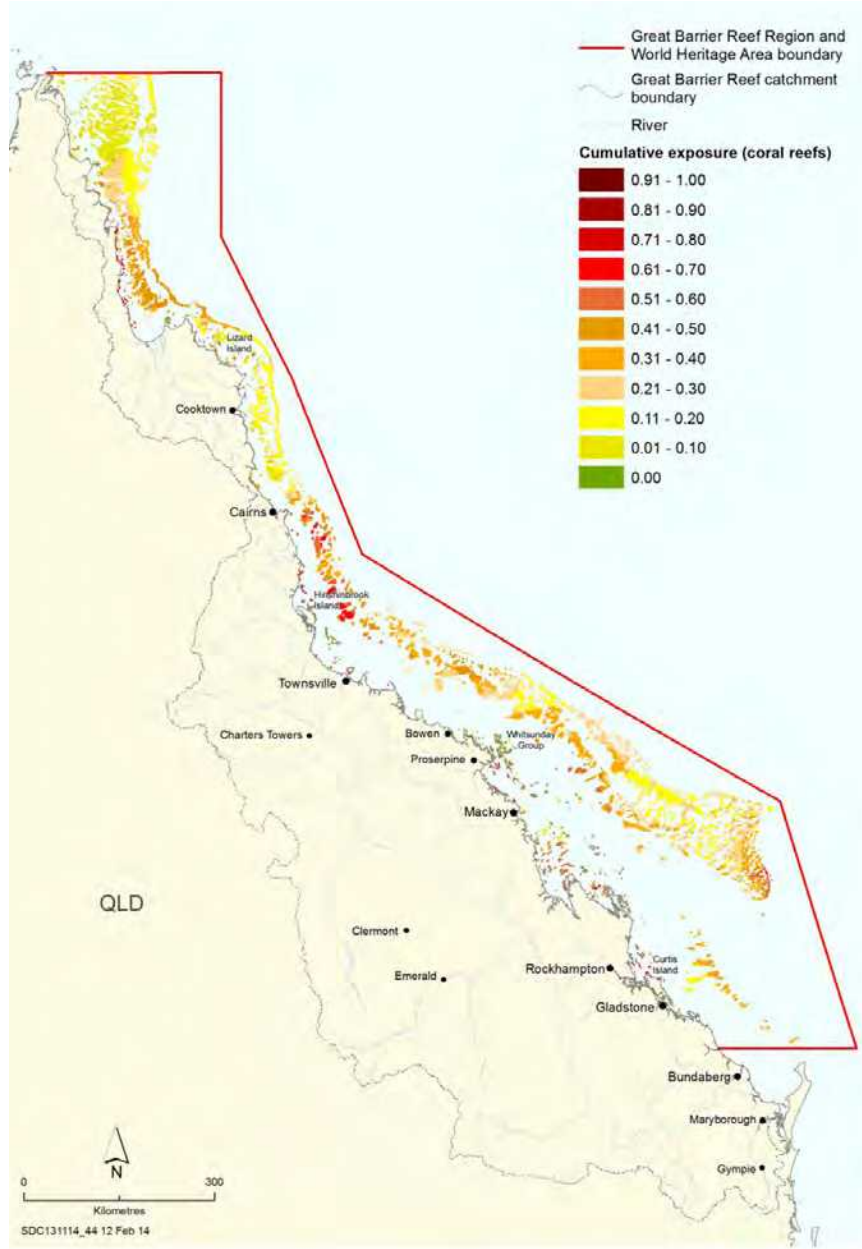


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The map notes that:

- Exposure to disturbance and coral health are not necessarily directly correlated
- The effect of disturbance depends on a reef's capacity to resist and recover.



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Reefs around Cairns and Townsville show areas of high disturbance.

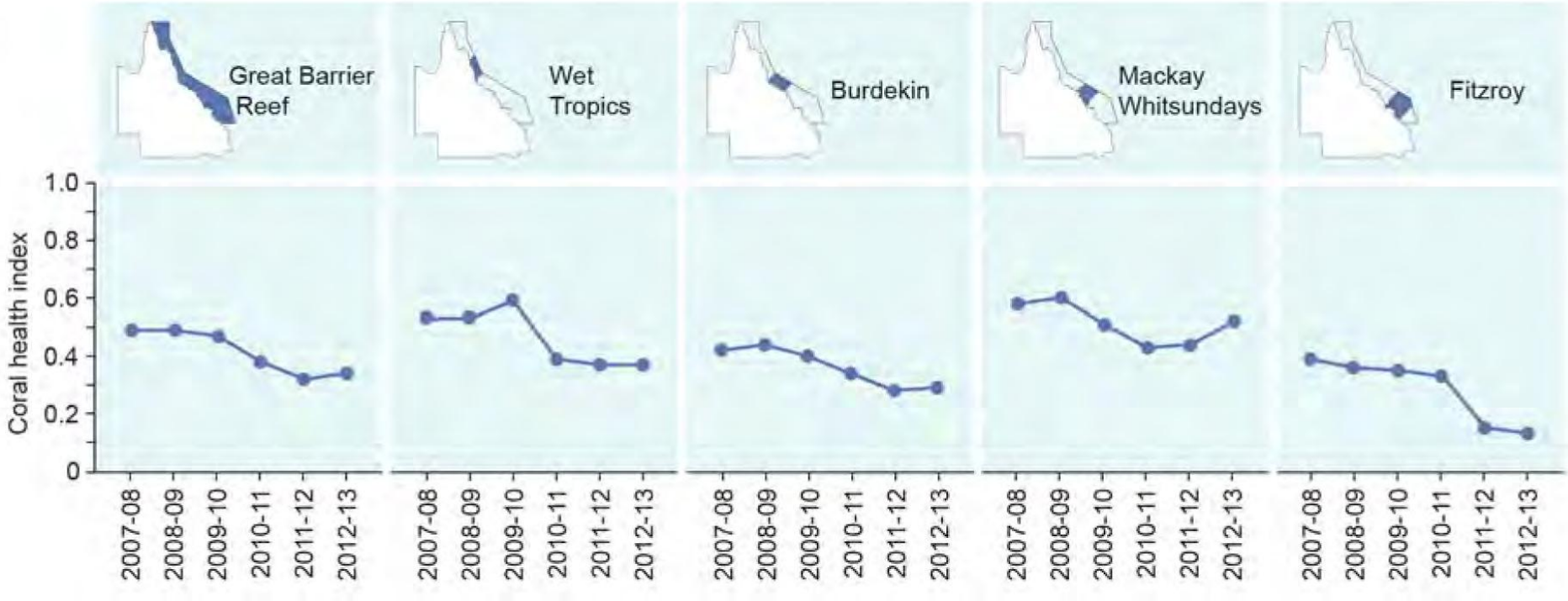


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Coral health index

A coral health index aggregates cover of corals, cover of macroalgae, density of juvenile corals and the rate of coral cover increase.
For corals to be considered in good or very good condition, they would have a score of 0.6 or more.

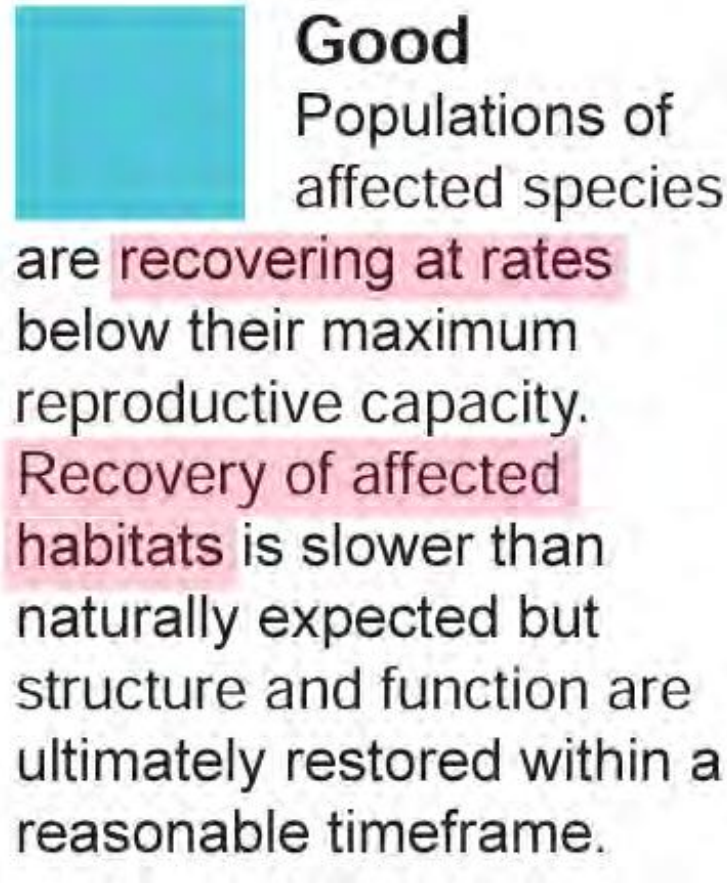


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If population rates recover below maximum reproductive capacity and habitats recover slower than expected, they are rated good.

On the proviso that habitat structure and function are ultimately restored within a reasonable time.



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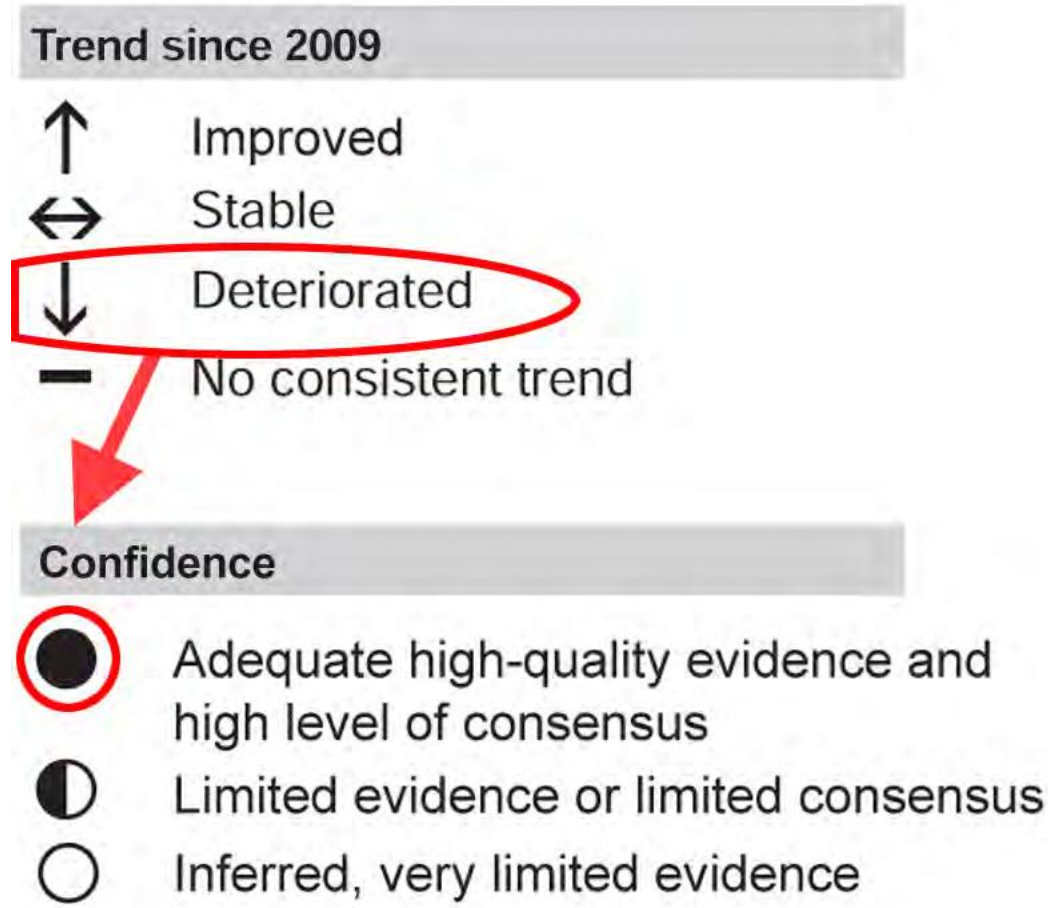
In the report, coral reef habitats get a poor rating because increases in the frequency of disturbances, have reduced the capacity of coral reefs to recover.

2009 Grade	Current summary and assessment components	Assessment grade and trend				Confidence	
				↓			
	Recovery in the ecosystem: Some disturbed populations and habitats have demonstrated recovery after disturbance (for example lagoon floor, loggerhead turtles, humpback whales). For some species recovery is not evident (black teatfish, dugongs) and is dependent on the removal of all threats. Increasing frequency and extent of some threats are likely to continue to reduce the resilience of species and habitats in the Region.	Very good	Good	Poor	Very poor	Grade	Trend
	Coral reef habitats: Increases in frequency and severity of disturbances, such as cyclones, flooding, crown-of-thorns starfish outbreaks have reduced the capacity for coral reefs to recover since 2009. There is evidence of recovery at a local scale.			↓		●	◐
	Lagoon floor habitats: Ongoing management arrangements mean that some lagoon floor habitats previously at risk are continuing to recover from disturbances. There is little monitoring of lagoon floor condition or recovery.		↔			◐	◐
	Black teatfish: Based on recent modelling, populations of black teatfish in the Region are likely to be slowly recovering. Populations have recovered in Torres Strait.				↑	◐	◐
	Coral trout: Coral trout populations demonstrate a strong ability to recover and increased reproduction in zones closed to fishing disperses beyond those zones. There are emerging concerns about the overall condition of coral trout populations.		–			◐	◐

http://elibrary.gbrmpa.gov.au/jspui/handle/11017/2855

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And they have deteriorated based on a high level of evidence.



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And there are some reefs that just do not recover at all.









(2012 photograph © The University of Queensland, courtesy of Tara Clark)



Figure 2.2 Inshore coral reefs over time, Stone Island, offshore Bowen
Historical photographs of inshore coral reefs have been especially powerful in illustrating changes over time.

The changes in the fringing reefs at Stone Island are typical of many inshore reefs. They largely took place before monitoring programs began — illustrating that modern assessments of the condition of coral reefs are likely to be based on an already shifted baseline.

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So, this is a case study of how the terms ecosystem resilience, disturbance and recovery are applied in the indication of ‘health’ of marine environments.



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Summary

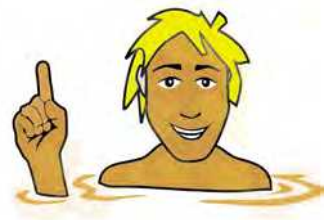
- An ecosystem without resilience may not recover from a disturbance
- A resilient ecosystem can recover more easily.
- Without disturbance, recovery is not needed.



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Question

Show how the Great Barrier Reef report 2014 uses resilience, disturbance and recovery to report on the health of the reef by listing the pages and making a summary of each.





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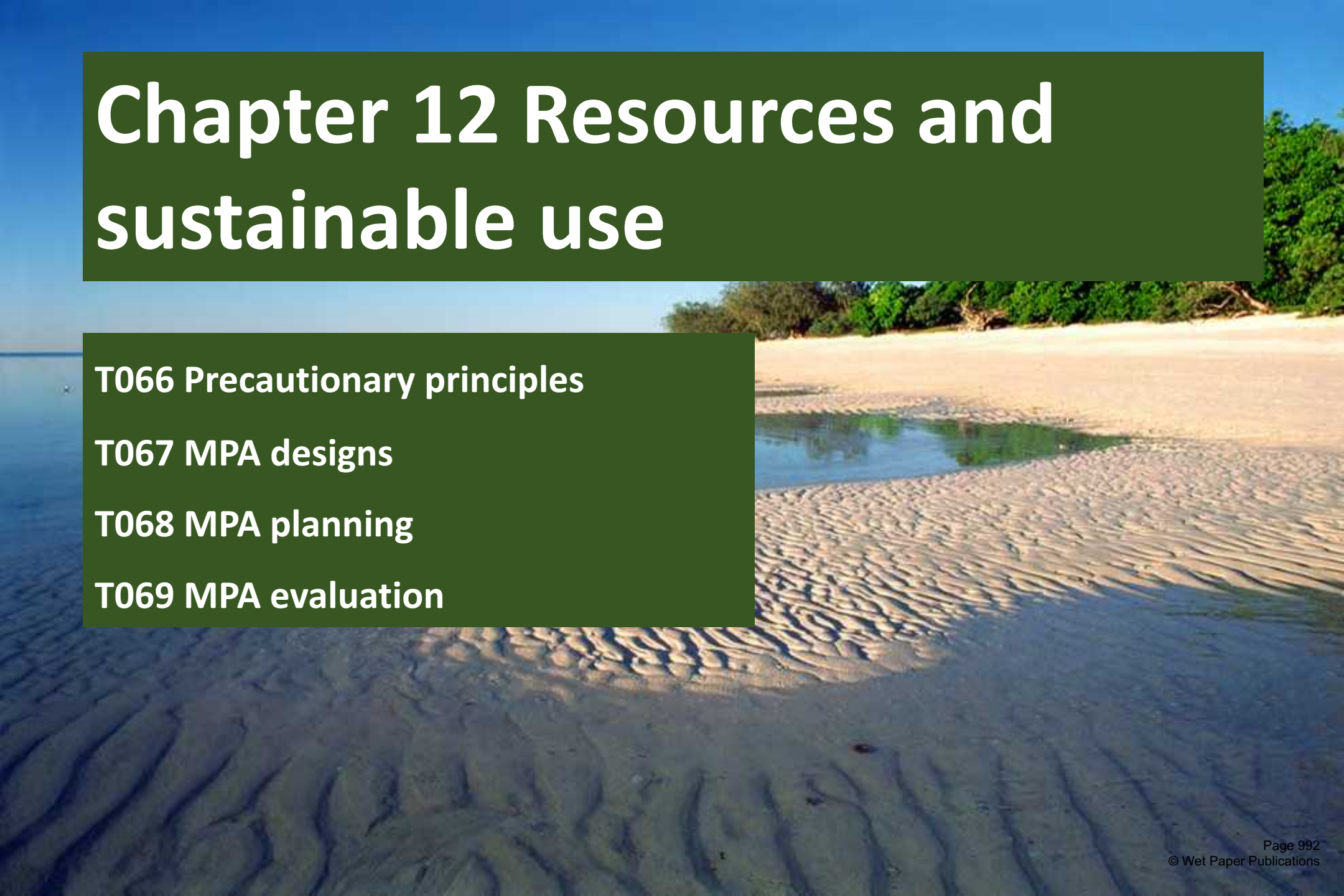
Chapter 12 Resources and sustainable use

T066 Precautionary principles

T067 MPA designs

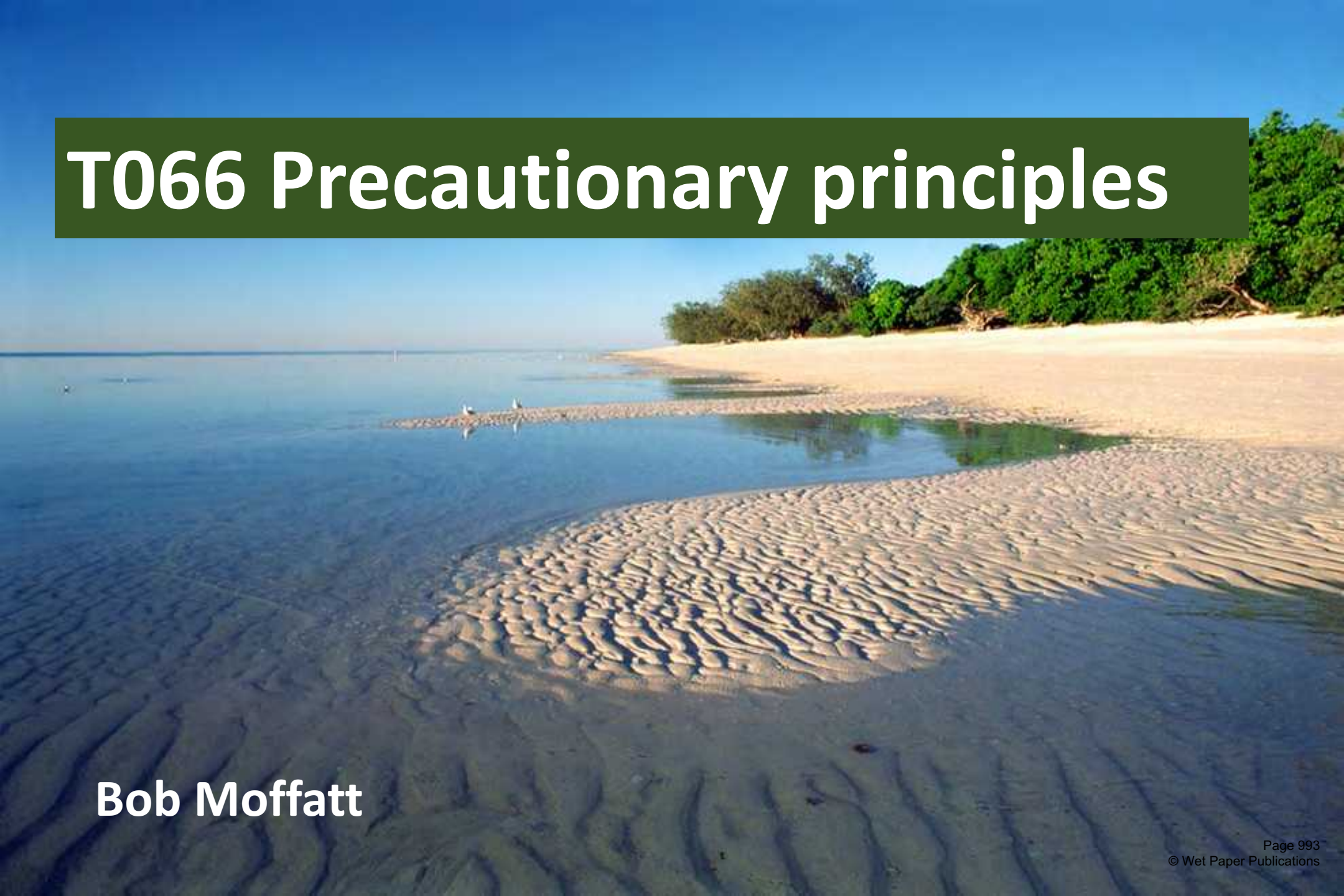
T068 MPA planning

T069 MPA evaluation



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T066 Precautionary principles



Bob Moffatt

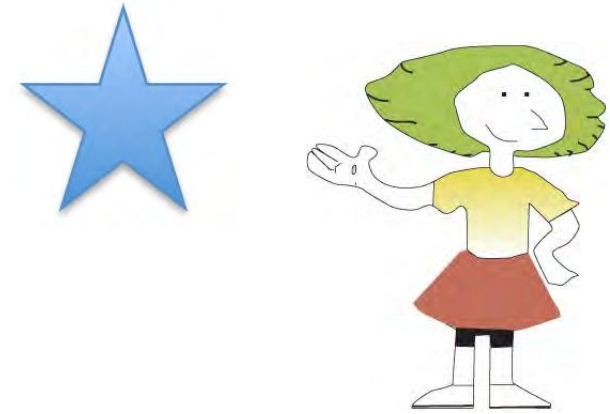
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Syllabus statement

At the end of this topic you should be able to ...

Recall

the precautionary principle of the marine environmental planning and management process as well as a requirement that any network of marine protected areas be comprehensive, adequate and representative.



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Recall

remember; present remembered ideas, facts or experiences; bring something back into thought, attention or into one's mind.

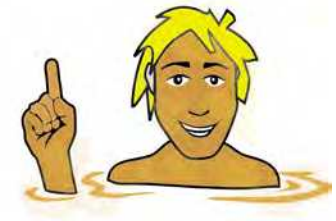


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Objectives

1. To give an example of the precautionary principle in marine environmental planning and management.

2. To list three requirements that are used to establish the National Representative System of Marine Protected Areas.



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Precautionary principle

1. The precautionary principle defines actions on issues considered to be uncertain.

2. The principle is used by policy makers to justify discretionary decisions in situations where there is the possibility of harm from making a certain decision (e.g. taking a particular course of action) when extensive scientific knowledge on the matter is lacking.



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The principle implies that there is a social responsibility to protect the public from exposure to harm, when scientific investigation has found a plausible risk.

These protections can be relaxed only if further scientific findings emerge that provide sound evidence that no harm will result.

Example:
When Gold Coast beach-front development began, no one thought of future beach erosion and storms, let alone global climate change.



Australian Womens Weekly

© Wet Paper Publications

When fishermen began trawling up vast numbers of deep water orange roughy, they had no idea they lived over 100 years and their age to maturity is estimated to be between 23 and 31 years of age.



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NSW Fisheries

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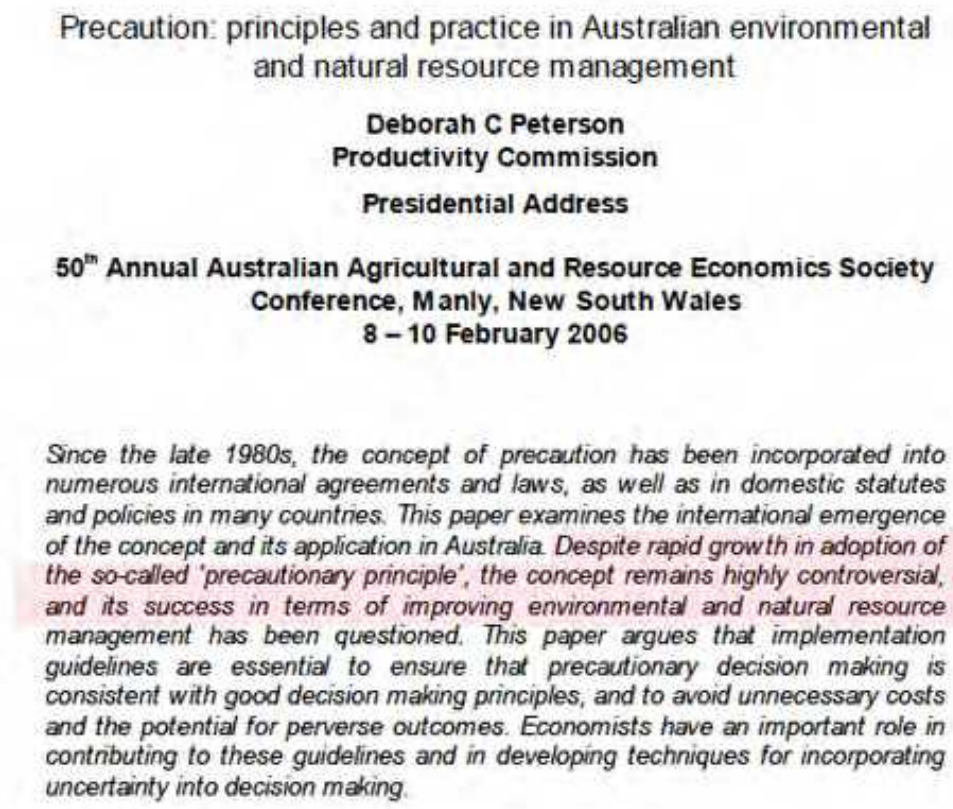
A precautionary approach is part of Ecological Sustainable Development (ESD) that improves the total quality of life, both now and in the future, in a way that maintains the ecological processes on which life depend.



By AleSpa - Own work, CC BY-SA 3.0,
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However the adoption of the principal is controversial.



Precaution: principles and practice in Australian environmental and natural resource management

Deborah C Peterson
Productivity Commission

Presidential Address

50th Annual Australian Agricultural and Resource Economics Society Conference, Manly, New South Wales
8 – 10 February 2006

Since the late 1980s, the concept of precaution has been incorporated into numerous international agreements and laws, as well as in domestic statutes and policies in many countries. This paper examines the international emergence of the concept and its application in Australia. Despite rapid growth in adoption of the so-called 'precautionary principle', the concept remains highly controversial, and its success in terms of improving environmental and natural resource management has been questioned. This paper argues that implementation guidelines are essential to ensure that precautionary decision making is consistent with good decision making principles, and to avoid unnecessary costs and the potential for perverse outcomes. Economists have an important role in contributing to these guidelines and in developing techniques for incorporating uncertainty into decision making.

the concept remains highly controversial,

Reference

https://www.pc.gov.au/research/supporting/precaution/precaution.pdf

https://www.pc.gov.au/research/supporting/precaution/precaution.pdf

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Some options for implementing precaution

- Deferral of a decision until more information is available ('wait and see' approach).
- Research into alternative, less damaging options, and/or provision of funding for the development of such alternatives.
- Mandatory environmental impact assessments, which increase the amount of information available to decision makers and may identify uncertainties and potential hazards associated with the proposed activity.
- Inclusion of 'safety margins' or 'uncertainty factors' in risk assessments. Safety margins are commonly applied in assessing risks from exposure to toxic substances and non-carcinogenic food additives.
- Adaptive management involving the identification of knowledge gaps, ongoing monitoring and research to improve the knowledge base, and incorporation of flexibility and reversibility into decisions so that measures can be modified in line with advances in information.
- Actions to increase the resilience of social or ecological systems, that is, their capacity to recover from or adapt to changed conditions.
- Use of the best available technology.
- Imposition of conditions on the use of new products, processes or technologies, and monitoring of environmental or public health and safety impacts.
- Requirements for pre-approval or product registration prior to placing products on the market, or for obtaining permits to undertake specific activities.

  Examples include:

  approvals required to permit the sale or use of food additives, drugs, medical devices, or pesticides; licensing of hazardous waste facilities, nuclear power plants, aquaculture operations, and commercial fishing; and permits for development proposals and water diversions.
- Banning of an activity until there is 'reasonable certainty' of safety.
- Banning of the activity until there is strong evidence of safety.

Sources: Compiled from Cameron 1999; CEC 2003; Deville and Harding 1997; Gullett 1997; Wills 2006; Young 1993.

https://www.pc.gov.au/research/supporting/precaution/precaution.pdf

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Some say yes, some say no

– so be aware in your recollection of this one.

Selected Australian formulations of the precautionary principle

Commonwealth

Inter-Governmental Agreement on the Environment 1992, para. 3.5.1: Where there are threats of serious or irreversible environmental damage, lack of full scientific certainty should not be used as a reason for postponing measures to prevent environmental degradation. In the application of the precautionary principle, public and private decisions should be guided by: (i) careful evaluation to avoid, wherever practicable, serious or irreversible damage to the environment; and (ii) an assessment of the risk-weighted consequences of various options.

Environment Protection and Biodiversity Conservation Act 1999, s. 391: The Minister must take account of the precautionary principle in making a decision … to the extent he or she can do so consistently with the other provisions of this Act. The precautionary principle is that lack of full scientific certainty should not be used as a reason for postponing a measure to prevent degradation of the environment where there are threats of serious or irreversible environmental damage.

Gene Technology Act 2000: Where there are threats of serious or irreversible environmental damage, a lack of full scientific certainty should not be used as a reason for postponing cost-effective measures to prevent environmental degradation.

Sources: Commonwealth and state legislation

New South Wales

Protection of the Environment Administration Act 1991: … if there are threats of serious or irreversible environmental damage, lack of full scientific certainty should not be used as a reason for postponing measures to prevent environmental degradation.

Victoria

Environment Protection Act 1970: (1) If there are threats of serious or irreversible environmental damage, lack of full scientific certainty should not be used as a reason for postponing measures to prevent environmental degradation. (2) Decision making should be guided by: (a) a careful evaluation to avoid serious or irreversible damage to the environment wherever practicable; and (b) an assessment of the risk-weighted consequences of various options.

South Australia

Environment Protection Act 1993: … to apply a precautionary approach to the assessment of risk of environmental harm and ensure that all aspects of environmental quality affected by pollution and waste (including ecosystem sustainability and valued environmental attributes) are considered in decisions relating to the environment.

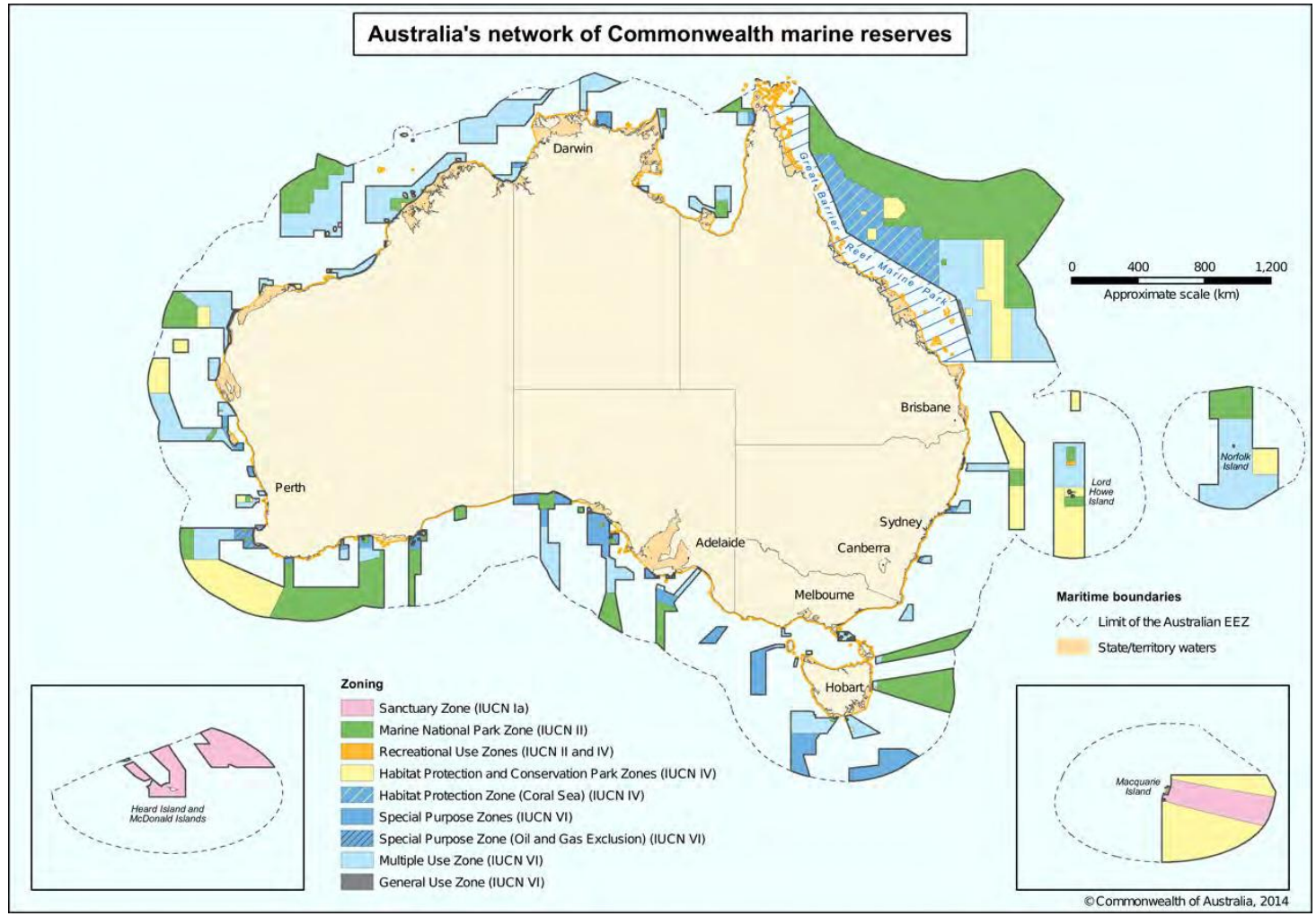
Tasmania

Environment Management and Pollution Control Act 1994: … to adopt a precautionary approach when assessing environmental risk to ensure that all aspects of environmental quality, including ecosystem sustainability and integrity and beneficial uses of the environment, are considered in assessing, and making decisions in relation to, the environment.

https://www.pc.gov.au/research/supporting/precaution/precaution.pdf

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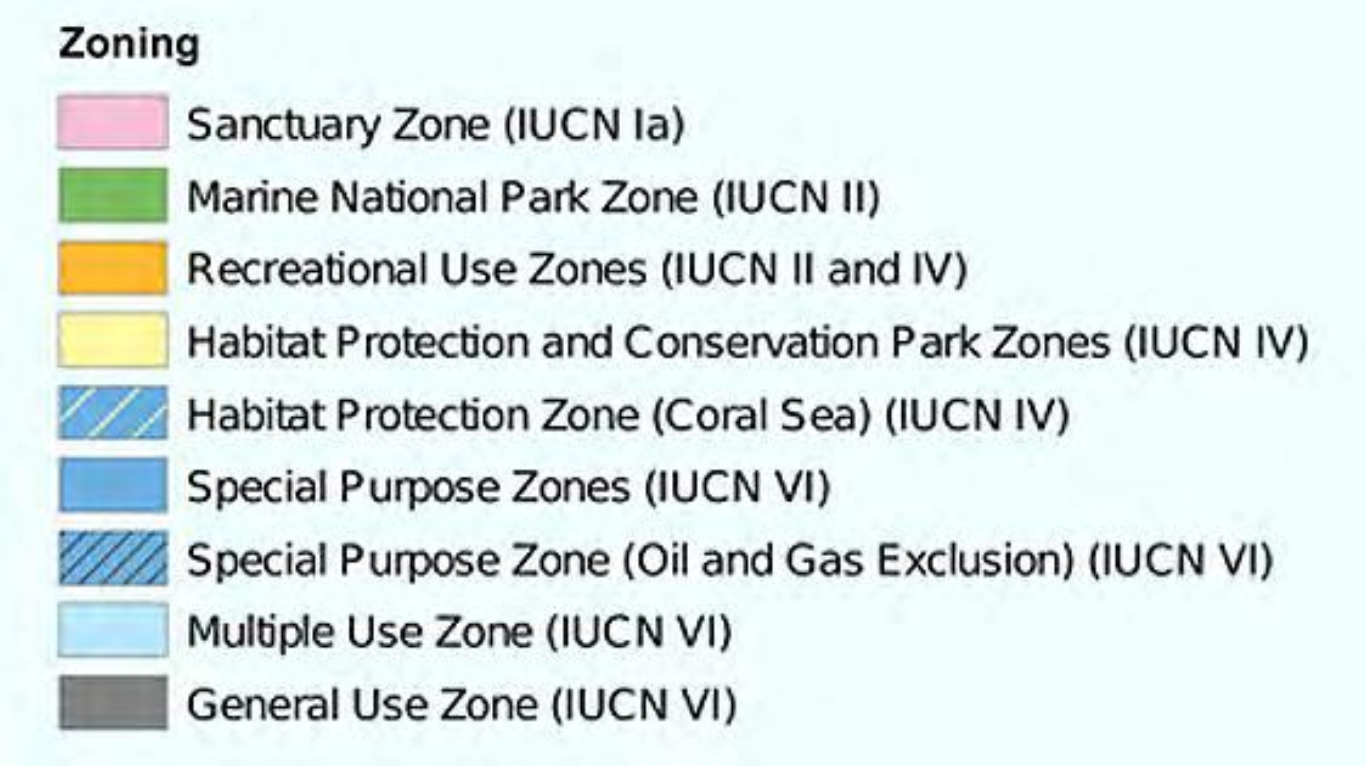
In 2012, Australia created a network of marine parks.



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This network had a series of zones with restricting activities.



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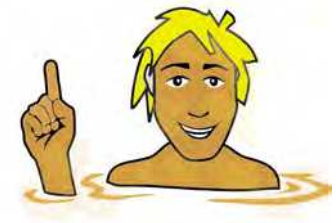
So, you have to remember the following three requirements:

Use **C A R**

Comprehensive - has a range of ecosystems,

Adequate - has an appropriate size and configuration

Representative - has representative marine life and habitats

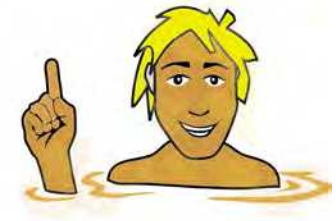


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Questions

1. What is the precautionary principle in marine environmental planning and management? Give an example.

2. List three requirements that are used to establish the National Representative System of Marine Protected Areas.



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T067 MPA designs



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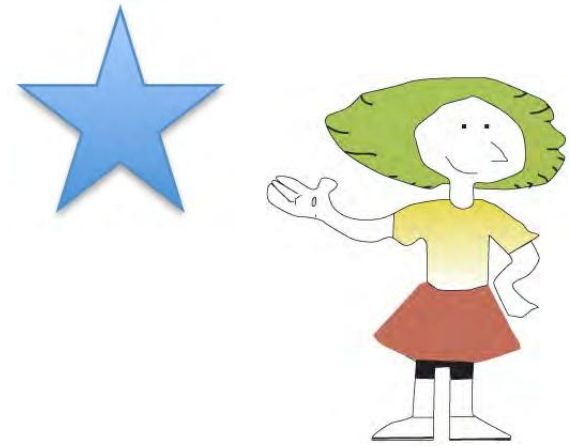
Syllabus statement

At the end of this topic you should be able to ...

Understand

that criteria are used to inform decisions regarding the design of protected marine areas.

The syllabus should say
that criteria are used to inform decisions regarding
the design of marine protected areas (MPA).

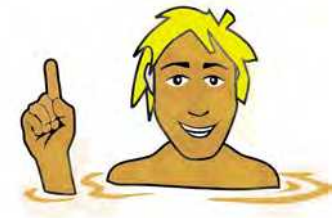


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Understand

recall - remember; present remembered ideas, facts or experiences; bring something back into thought, attention or into one's mind.





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Objective

To list three environmental criteria for places to be included into a marine park?



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One set comes from ANZECC The Australian and New Zealand Environment and Conservation Council

The guidelines

Guidance on Achieving Comprehensiveness, Adequacy, and Representativeness in the Commonwealth waters component of the National Representative System of Marine Protected Areas

The Scientific Peer Review Panel for the National Representative System of Marine Protected Areas

February 20, 2006

Purpose

The purpose of this paper is to outline the approach of the Scientific Peer Review Panel for the National Representative System of Marine Protected Areas (the Peer Review Panel) in assessing the principles of comprehensiveness, adequacy and representativeness of Marine Protected Area (MPA) proposals for inclusion in the Commonwealth waters component of the National Representative System of Marine Protected Areas (NRSMPA). The advice provided in this paper is based on national guidelines produced by the Australian and New Zealand Environment and Conservation Council (ANZECC) for establishing a comprehensive, adequate and representative MPA system[1].

Criteria

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This set of criteria uses CAR guidelines

The Australian Government: Statements relating to MPA Development

The ANZECC guidelines to assist governments to develop a NRSMPA will be:

- Comprehensive: include MPAs that sample the full range of Australia's ecosystems;
- Adequate: include MPAs of appropriate size and configuration to ensure the conservation of marine biodiversity and integrity of ecological processes; and
- Representative: include MPAs that reflect the marine life and habitats of the areas they are chosen to represent.

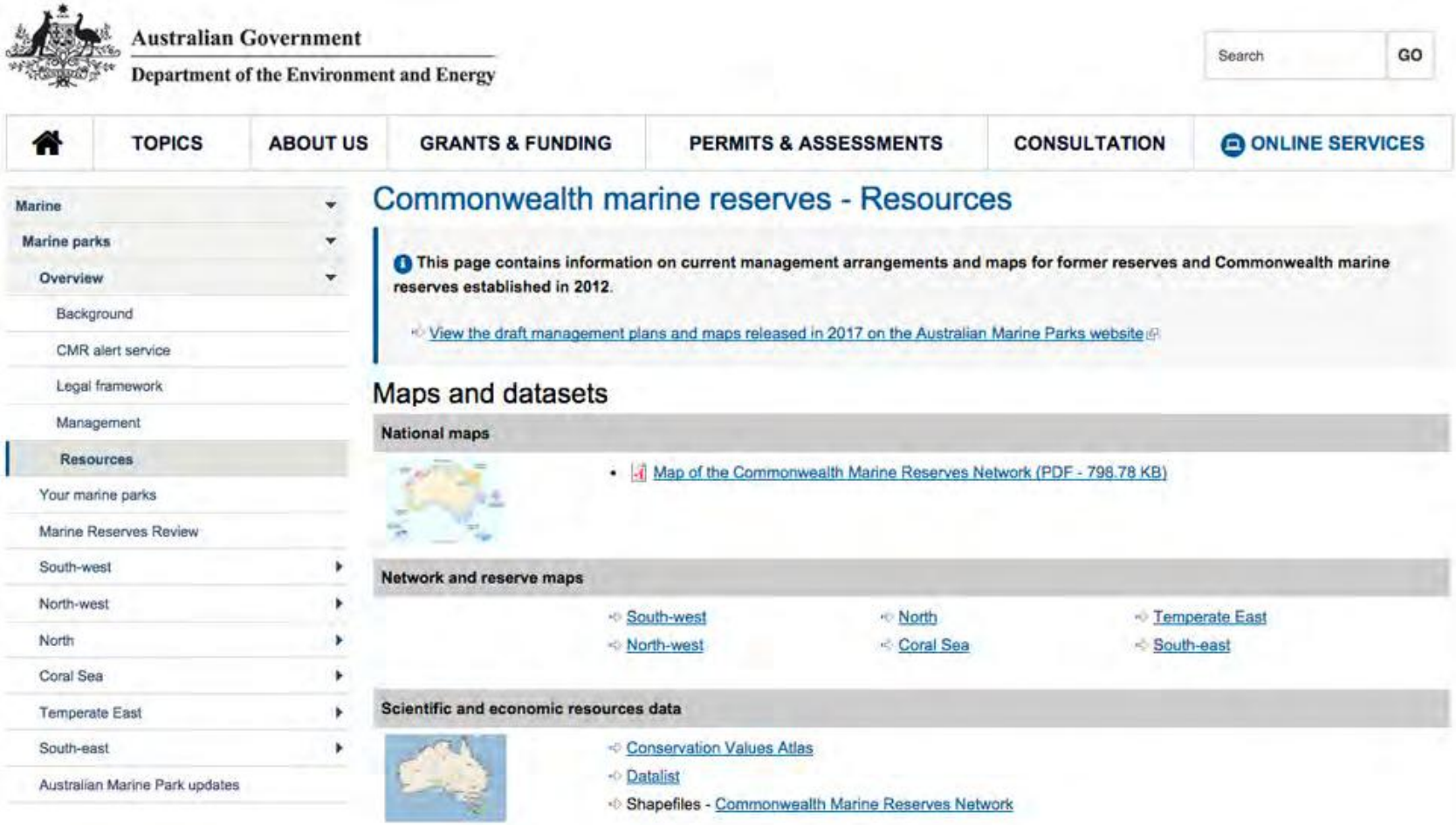
The ANZECC documents recognize that governments will interpret the Guidelines so that they are effectively integrated with existing processes and legislation in each jurisdiction.

http://www.environment.gov.au/resource/guidance-achieving-comprehensiveness-adequacy-and-representativeness-commonwealth-waters

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Another set can be found at:

http://www.environment.gov.au/topics/marine/marine-reserves/overview/resources



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And still another in the reef 2050 documents

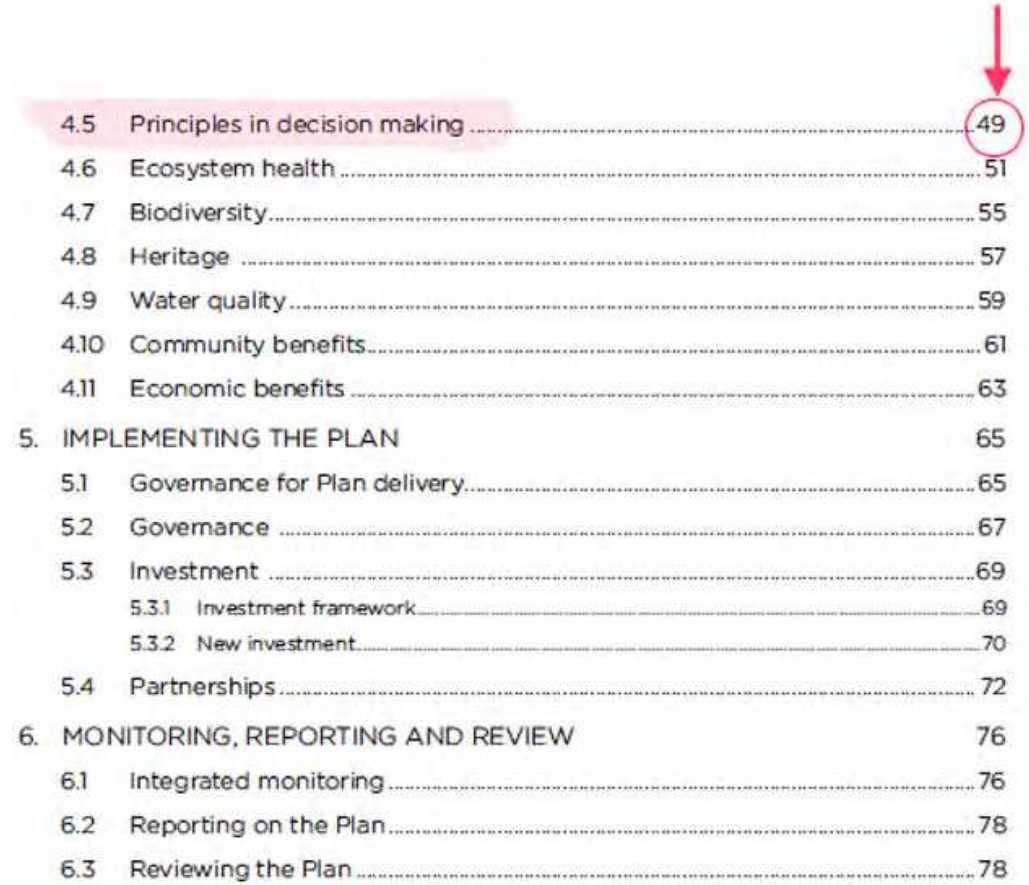


http://www.environment.gov.au/marine/gbr/publications/reef-2050-long-term-sustainability-plan-2018

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Pages 49 - 50 discusses the following principles in decision making

- Maintaining and enhancing outstanding universal value in every action
- Basing decisions on the best available science
- Delivering a net benefit to the ecosystem
- Adopting a partnership approach to management



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http://www.environment.gov.au/marine/gbr/publications/reef-2050-long-term-sustainability-plan-2018

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Principles in decision making

Maintaining and enhancing Outstanding Universal Value in every action

- Protecting the Outstanding Universal Value of the World Heritage Area is the prime consideration when planning, development and management decisions are made.
- Values and ecological processes in poor condition are restored and values and ecological processes in good condition are maintained.
- Economic growth is sustainable and consistent with protecting Outstanding Universal Value.

http://www.environment.gov.au/marine/gbr/publications/reef-2050-long-term-sustainability-plan-2018

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Principles in decision making

In making decisions about management and protection of the World Heritage Area, decision makers will have regard to the principles set out below.

Basing decisions on the best available science

- Decisions are based on the full range of knowledge, including scientific understanding, Traditional Owner and community knowledge.
- Decisions take into consideration information on the current and emerging risks associated with climate change.
- Management is adaptive and continually improving, informed by the outcomes of monitoring programs.

http://www.environment.gov.au/marine/gbr/publications/reef-2050-long-term-sustainability-plan-2018

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Principles in decision making

Delivering a net benefit to the ecosystem

- Decisions are underpinned by the principles of ecologically sustainable development, including the precautionary principle.
- Impacts are avoided and residual impacts mitigated.
- Offsets are considered only where impacts cannot be avoided or mitigated.
- Actions that restore ecosystem health and resilience—delivering an overall improvement in the Reef's condition—are fostered.

http://www.environment.gov.au/marine/gbr/publications/reef-2050-long-term-sustainability-plan-2018

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Principles in decision making

Adopting a partnership approach to management

- Governance arrangements are transparent and accountable.
- Decisions continue to support a wide range of opportunities for sustainable economic, social and cultural activities, including traditional use.
- Management is cooperative; empowering partners, fostering stewardship and building strong community support. Delivery of local and regional actions is informed through engagement with Traditional Owners, industry, regional bodies, local governments and the community.
- Innovation in management is fostered.

http://www.environment.gov.au/marine/gbr/publications/reef-2050-long-term-sustainability-plan-2018

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So do you now understand

that criteria are used to inform decisions regarding the design of marine protected areas?



✗ ✓



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Question

What are some environmental criteria for inclusion into a marine park?



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For further understanding



http://www.environment.gov.au/marine/gbr/publications/reef-2050-long-term-sustainability-plan-2018

You can download and read this publication:

http://www.environment.gov.au/marine/gbr/publications/reef-2050-long-term-sustainability-plan-2018

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T068 MPA planning



Bob Moffatt

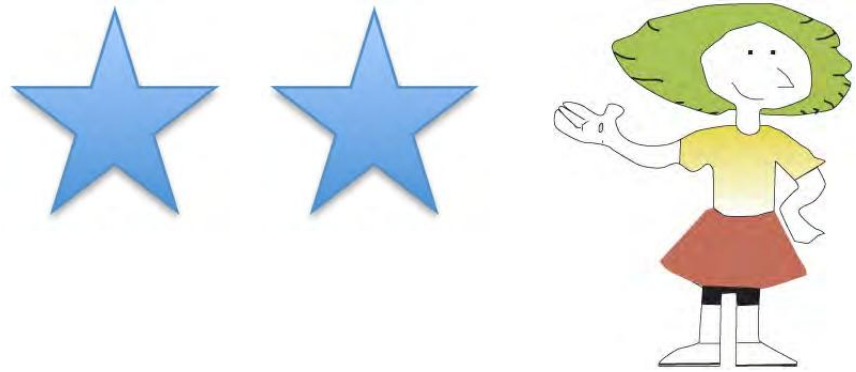
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Syllabus statement

At the end of this topic you should be able to ...

Compare

the strategies and techniques used for marine environmental planning and management with reference to a specific case study

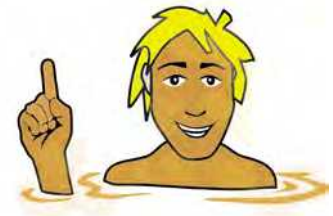


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Compare

display recognition of similarities and differences and recognise the significance of these similarities and differences





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Objective

Read the information on the following pages and complete a table comparing the strategies and techniques that could apply to a local marine park or protected area using examples of each.

Compare the strategies and techniques used for marine environmental planning and management with reference to a specific case study

Strategies and technique	Example	Comparison with other strategies and techniques
Zoning plans		
Regulations and standards		
Approvals and permits		
Protection of threatened or significant species		
Protection of threatened habitats and ecosystems		
Multiple-use marine protected areas		
Controls of harmful activities		
Controls on discharges		
Environmental impact assessment		
Economic tools and user-pays		
Environmental restoration		
Clean-up techniques for oil spills		
Prevention of accidents at sea		
Biosecurity measures		
Technological advances		
Action on land to reduce diffuse pollution		
Personal actions		
Engage stakeholders		

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Suggested answer

Compare the strategies and techniques used for marine environmental planning and management with reference to a specific case study

Strategies and technique	Example	Comparison with other strategies and techniques
Zoning plans	MPA	Defines an area that can be regulated as opposed to one that is unregulated
Regulations and standards	Mooring on reef floor	Sets standard to which moorings can be manufactured as opposed to poor quality materials
Approvals and permits	Development applications	Controls biodiversity by rules and regulations. Can be objected to and can be rejected by local authorities
Protection of threatened or significant species	Whales	Identifies species so education can occur as opposed to do what you like with this species
Protection of threatened habitats and ecosystems	Mangroves	Allows legislation, laws and subsequent legal actions again law breakers. Also allows development applications to be processed.
Multiple-use marine protected areas	Green zones and others	Provides access for all types of activities, while setting aside areas for preservation and biodiversity protection
Controls of harmful activities	Trawling	Sets specific times and places benthos trawling can occur
Controls on discharges	Sewage from boats	Prevents eutrophication of marinas and popular anchorages
Environmental impact assessment	Development applications	Allows biodiversity to be established
Economic tools and user-pays	Reef levy tax	Tax raises money for environmental protection
Environmental restoration	Coral re-growths	Growing new reefs that have died out due to climate change.
Clean-up techniques for oil spills	Ship grounding on reef	Allows rapid clean up to minimise environmental damage
Prevention of accidents at sea	Snorkelling deaths	Regulations of snorkelling industry
Biosecurity measures	Local pandanas disease	Prohibit movement of northern region pandanas to southern regions
Technological advances	Turtle exclusion nets	Allows turtles to escape from fishing nets
Action on land to reduce diffuse pollution	Plastic bags	Legislate to stop ussie of single use plastic bags
Personal actions	Plastic bags	Education to stop using plastic as carry bags
Engage stakeholders	Plastic bags	Education to stop using plastic as carry bags

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Reference

Chapter 18
Marine Science for Australian Schools
Moffatt, Zann and Ryan
Pages 471 – 475

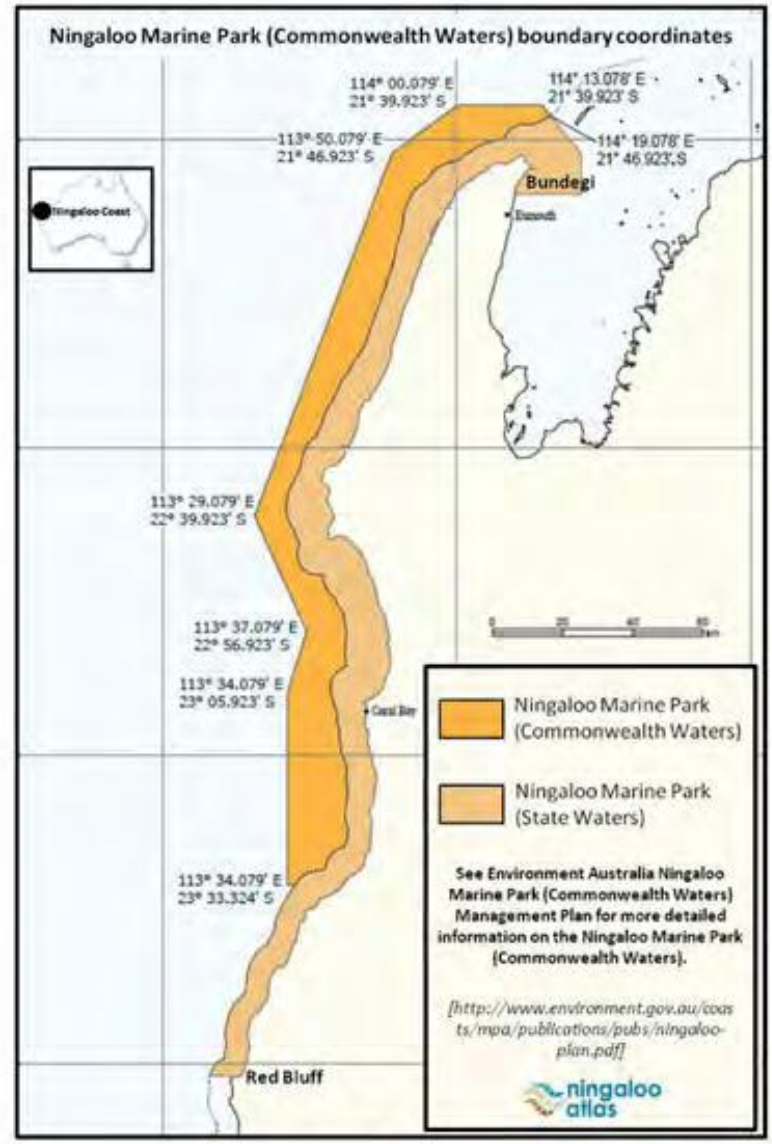
“Strategies and techniques for planning and management”



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Strategies and techniques for planning and management

A variety of strategies and techniques are used for planning and management of the marine environment, and new techniques are being developed.



CALM WA

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Legislation and regulations

Environmental agencies, plans and regulations, must be made legal through parliamentary legislation.

The Commonwealth and State Government parliaments control different aspects of the marine environment, and Local Councils control local coastal development through town planning and by-laws.

The Commonwealth is also responsible for implementing International Laws and agreements, such as the Law of the Sea.



Australian Government
Department of the Environment



Queensland Government

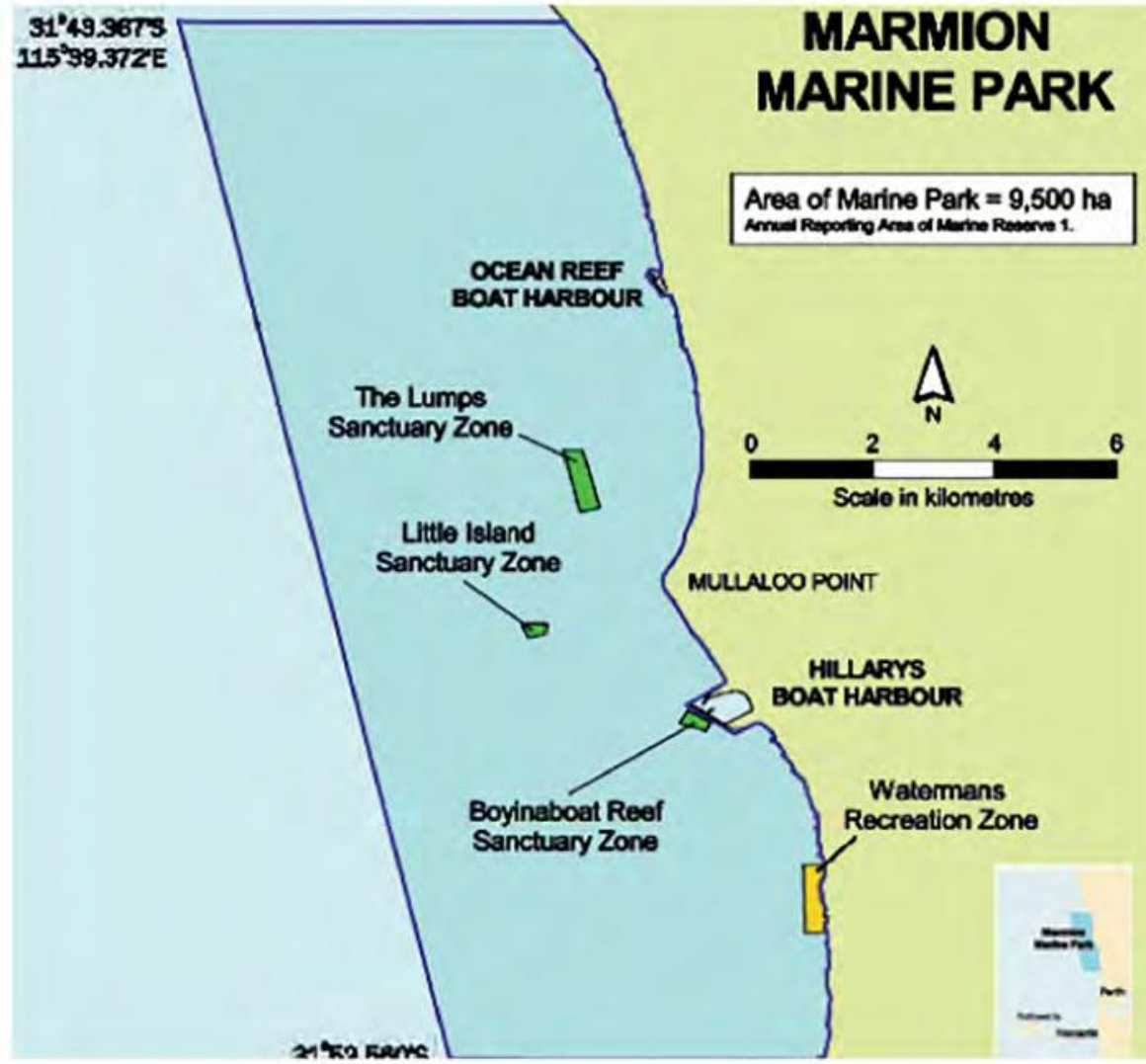
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Zoning plans

Zoning plans or maps are a basic tool for large-scale, long-term environmental planning.

Each zone stipulates the intended purpose of the area (conservation, commercial or recreational fishing, aquaculture, shipping, tourism) and the types and levels of uses or developments which are permitted and prohibited there.

These are like the town plans used by Local Councils. Zoning plans are important tools in marine protected areas.



CALM WA

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Regulations and standards

The activities permitted in each zone will also be subject to regulations developed to minimise their environmental impacts.

These include design standards for:

- buildings and structures,
- installation of litter traps in drains,
- planted wetlands to reduce runoff,
- types of sewage treatment plants,
- types of fishing gear, and
- regulations on the amounts of chemicals and wastes allowed in discharges.



Bob Moffatt

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Approvals and permits

The amount of a specific activity or use allowed in each zoned area is regulated through a system of licences and permits.

Proposed users or developers must apply for a licence or permit.

This may not be granted if the area is reaching the limits for its sustainable use.



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Protection of threatened or significant species

Threatened, rare, endangered or other significant species may be totally protected from human hunting, fishing or collection, throughout the sea.

All whales and dolphins are totally protected in Australia.

Dugongs and turtles are protected, but may be taken by indigenous people in some areas.



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Protection of threatened habitats and ecosystems

Marine protected areas are an important planning and management strategy.

Ecosystems or areas which are important, limited or threatened, or are essential habitat for the survival of some threatened species, may be totally protected as a marine park or sanctuary.

Corals are protected on the Barrier Reef. Mangroves are protected in most states.



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Multiple-use marine protected areas

Large multiple-use marine protected areas are a very important planning and management strategy for biodiversity conservation and ecologically sustainable use.

They use zoning plans to protect areas of environmental importance, while allowing certain activities (recreational fishing, certain commercial fishing, research, shipping) in certain areas.

The Great Barrier Reef (Qld), Solitary Islands (NSW) and Ningaloo (WA) Marine Parks are designed to protect biodiversity while allowing sustainable human uses.



GBRMPA

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Controls on discharges

The levels of harmful substances that can be released in industrial or other discharges into rivers and the sea are regulated.

Maximum levels are based on scientific studies on effects on certain aquatic species, or on maximum levels allowable in foodstuffs.

People exceeding the maximum limits can be fined and forced to use appropriate discharge treatments, or closed down.



Wet Paper

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Environmental impact assessment

Environmental impact assessment (EIA) is a planning and management tool to assess possible harmful environmental effects of a proposed development such as a port, marina, industry, dam or housing estate.

The ecological, social and economic importance of the proposed site are examined, and possible harmful effects of the development or operation are identified.

If the developer cannot prevent or minimise these, the development is not approved.

EIAs are very time-consuming and very expensive (over $20,000 for a small one, millions for a large one).



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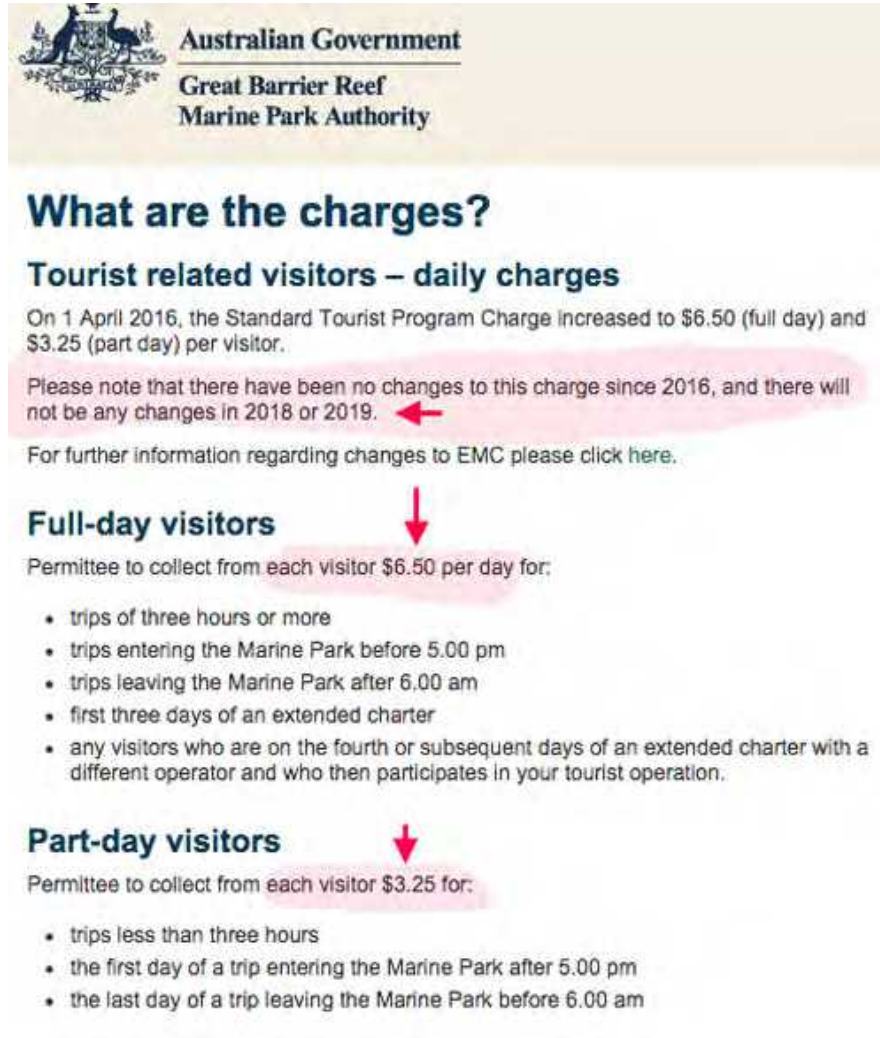
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Economic tools and user-pays

Licences and fees are used to regulate some activities, and to fund environmental management. Australian governments are introducing the policy of user pays, where the service user is charged for the service, rather than the general tax-payer.

Commercial fishers, and recreational fishers in some states, must pay licence fees to take fish.

Visitors to the Great Barrier Reef are charged a daily surcharge or tax which is used to fund reef research and management.



Australian Government
Great Barrier Reef Marine Park Authority

What are the charges?

Tourist related visitors – daily charges

On 1 April 2016, the Standard Tourist Program Charge increased to $6.50 (full day) and $3.25 (part day) per visitor.

Please note that there have been no changes to this charge since 2016, and there will not be any changes in 2018 or 2019.

For further information regarding changes to EMC please click here.

Full-day visitors

Permittee to collect from each visitor $6.50 per day for:

- trips of three hours or more
- trips entering the Marine Park before 5.00 pm
- trips leaving the Marine Park after 6.00 am
- first three days of an extended charter
- any visitors who are on the fourth or subsequent days of an extended charter with a different operator and who then participates in your tourist operation.

Part-day visitors

Permittee to collect from each visitor $3.25 for:

- trips less than three hours
- the first day of a trip entering the Marine Park after 5.00 pm
- the last day of a trip leaving the Marine Park before 6.00 am

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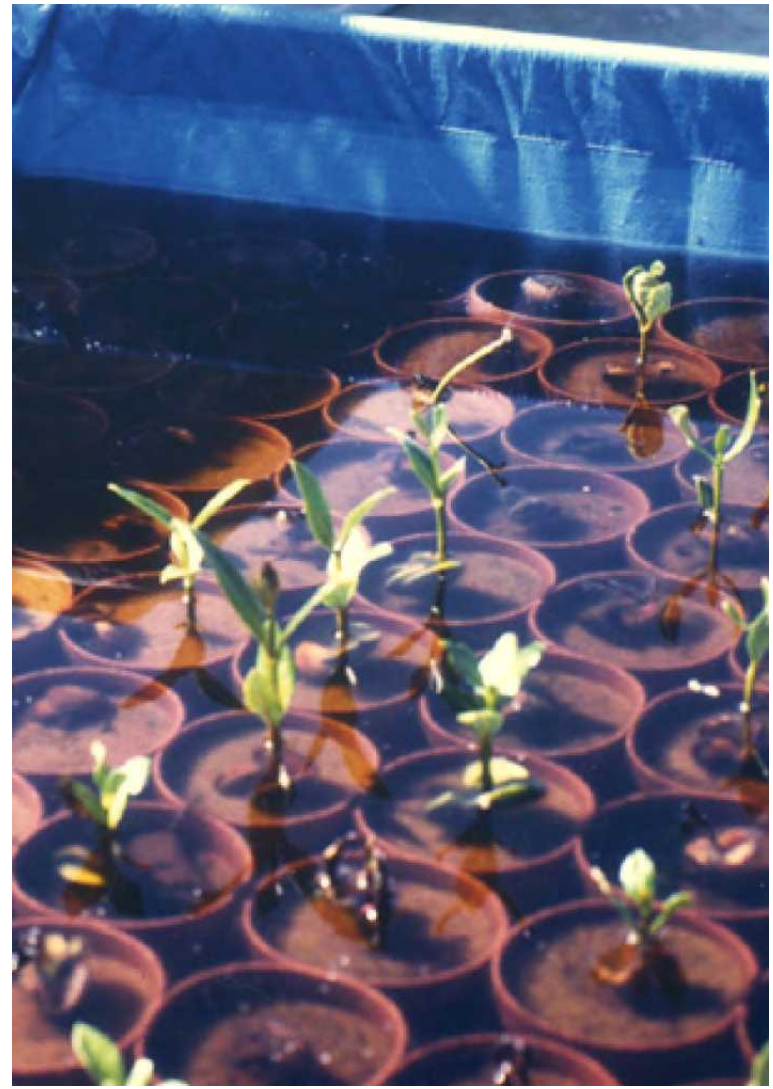
Environmental restoration

Because some environments have been seriously degraded or lost beyond natural repair, techniques have been developed for their restoration.

Seed banks are kept for colonising of pioneer species to naturally re-establish plant communities.

Genetic material of endangered species is being conserved, and in some cases artificially propagated.

Mangroves are replanted to replace cleared areas. Coastal developments which necessitate removal of mangroves, may have to plant an equivalent area to compensate the loss of production.



Glenn Leiper

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Techniques are being developed for re-establishing seagrasses, and corals. In parts of Northern NSW and Victoria, some of the wetlands which had been drained for cattle grazing are now being reflooded to re-create fisheries habitat.

Corals are also being regrown.



Bob Moffatt

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Cleanup techniques for oil spills

Bio-safe chemical dispersants, boom nets to contain spills, and skimmer boats to collect oil have been developed to clean up spills.

Oil-spill contingency plans have been prepared so the authorities can act quickly, even in remote areas.

Stockpiles of equipment are stored in strategic areas around the coastline.



AMSA

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Prevention of accidents at sea

Prevention is better than cure. Managers try to prevent accidents at sea and oil spills.

Satellite global positioning systems (GPS) are now used for pin-point navigation and have taken much of the risk from sea transport.

(GPSs are now being placed on fishing vessels so the authorities can monitor their position and actions at all times, and at minimal expense.)



AMSA

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Oil tankers are being constructed with double hulls in case of strandings.

Expert ship pilots are employed to take large ships, and those with hazardous cargoes, into ports, and through sensitive areas of the Great Barrier Reef.



AMSA

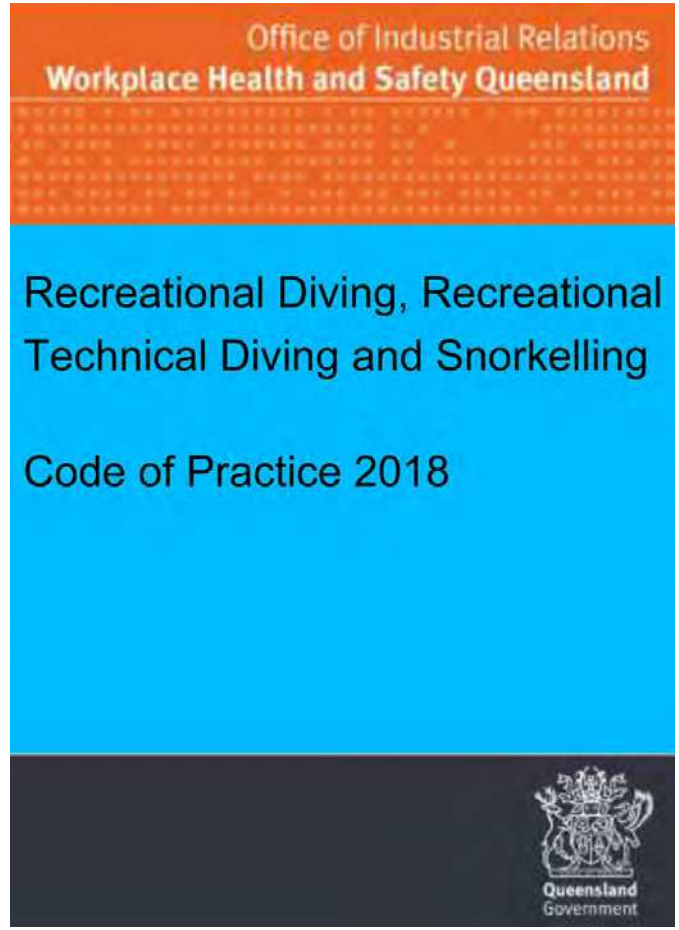
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Snorkelling and diving deaths

Codes of practice are in place to prevent deaths.



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https://www.worksafe.qld.gov.au/__data/assets/pdf_file/0004/152329/rec-diving-rec-tech-diving-snorkelling-COP-2018.pdf

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Biosecurity measures

The prevention of diseases and other problems from entering the marine environment is also very important. This is termed biosecurity (originally developed to prevent contagious diseases from entering chicken farms). Australia is a world leader in agriculture quarantine to keep our agricultural industries free from diseases and pests.



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The problem in the sea was not recognised until fairly recently with the introductions of toxic algae, Pacific oysters, Pacific seastars and Zebra mussels.

The transmission of diseases by aquaculture species is proving to be a potentially very serious problem.

The International Maritime Organisation in conjunction with UNESCO have conventions, educational programs and regulations to govern ballast waste and ships.





By Denelson83 - Derivative of Image:Flag of the United Nations.svg and an image at Flags of the World., CC BY-SA 3.0, https://commons.wikimedia.org/w/index.php?curid=4920392

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Technological advances

Just as the environmental crisis is the result of industrial technology, technology can provide solutions.

Polluting two-stroke outboards are being replaced by clean, small four-strokes.

New pesticides and antifouling paints have been developed which do not persist in the marine environment.

Filters can remove many emissions from coal stacks.

Solar and wind technology is rapidly improving, and becoming cheaper.

Solar cells are now widely used to power yachts' lights and marine navigation lights.



Internet – source unknown, but nice photoshopping!

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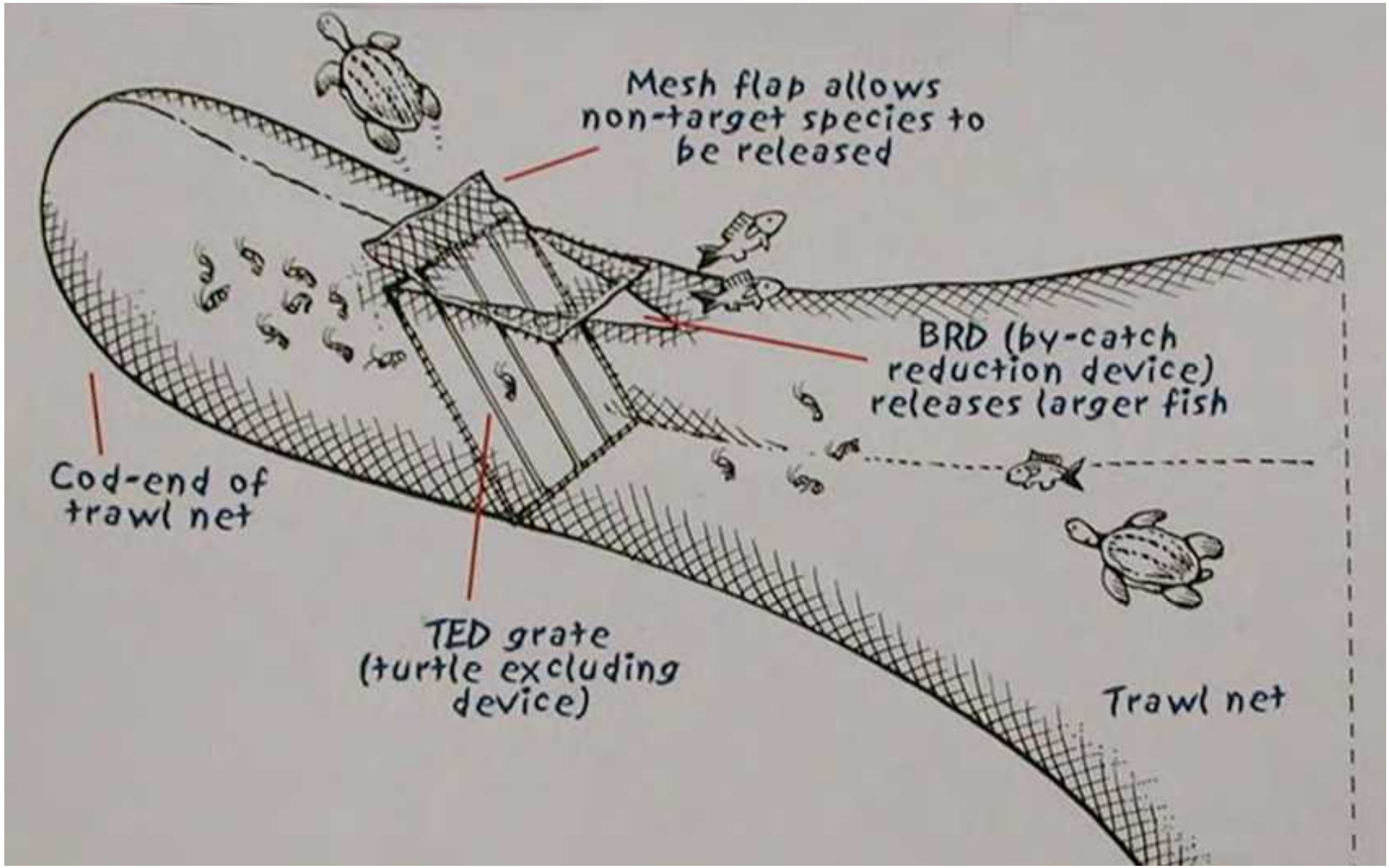
Fishing gear is being made more selective to reduce the catch of unwanted species.

Prawn trawl nets are now built with slots and shutes to exclude turtles and other bycatch.



Qld Fisheries

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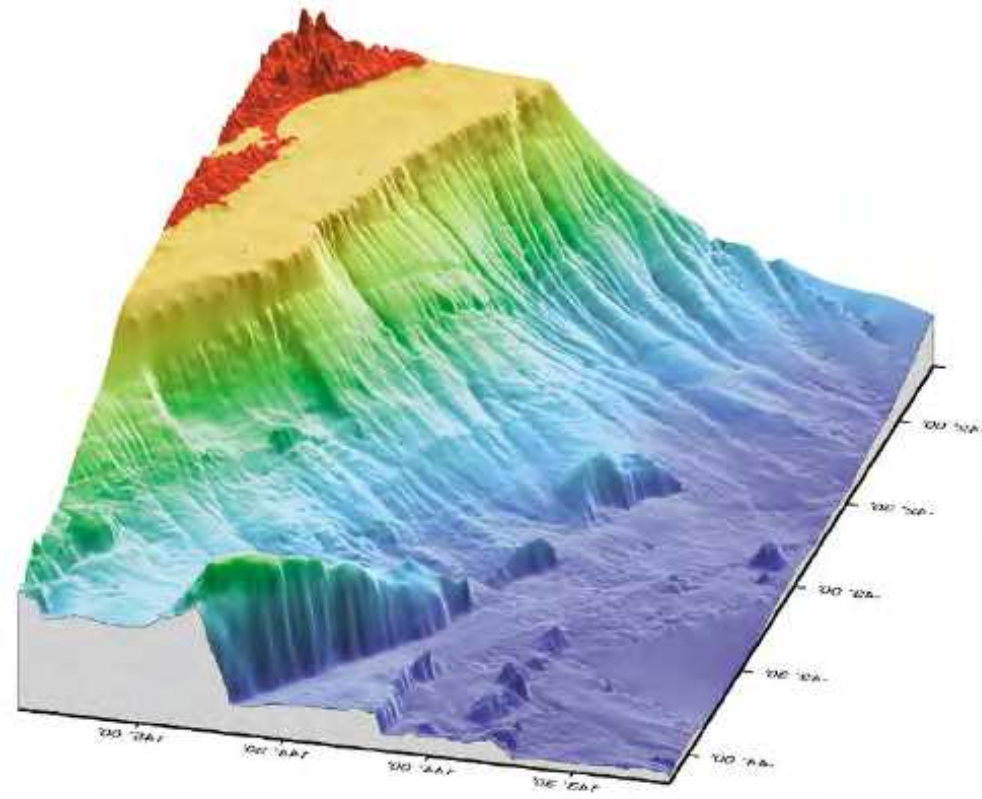
Computers and communications satellites have revolutionised electronic communications and are now indispensable tools in environmental education and management.

Pollution is now easily and cheaply monitored and modern electronic instruments can detect even a few molecules of a contaminant.

Sensors can then automatically telemeter or send their findings to a central computer.

Computer databases are used to store and analyse an ocean of complex data.

Computers can simulate or model complex ecosystems, predict events, and even make decisions for us.



Geoscience Australia

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Action on land to reduce diffuse pollution

The millions of small diffuse sources of pollution entering coastal catchments are possibly the greatest, and most difficult problem affecting Australia's marine environment.

Nevertheless, there have been some important advances in this area and agricultural practices are improving.

Sugar cane drains in NSW and Queensland, are being re-designed so that they are wider and shallower, so they do not expose acidic soils.



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Use of slow-release fertilisers is reducing runoff into the waterways and saving farmers a lot of money.

Litter traps are now added to stormwater drains to remove larger items of litter.

Sediment traps of synthetic fabric are used on land and sea to contain erosion and suspended silt.



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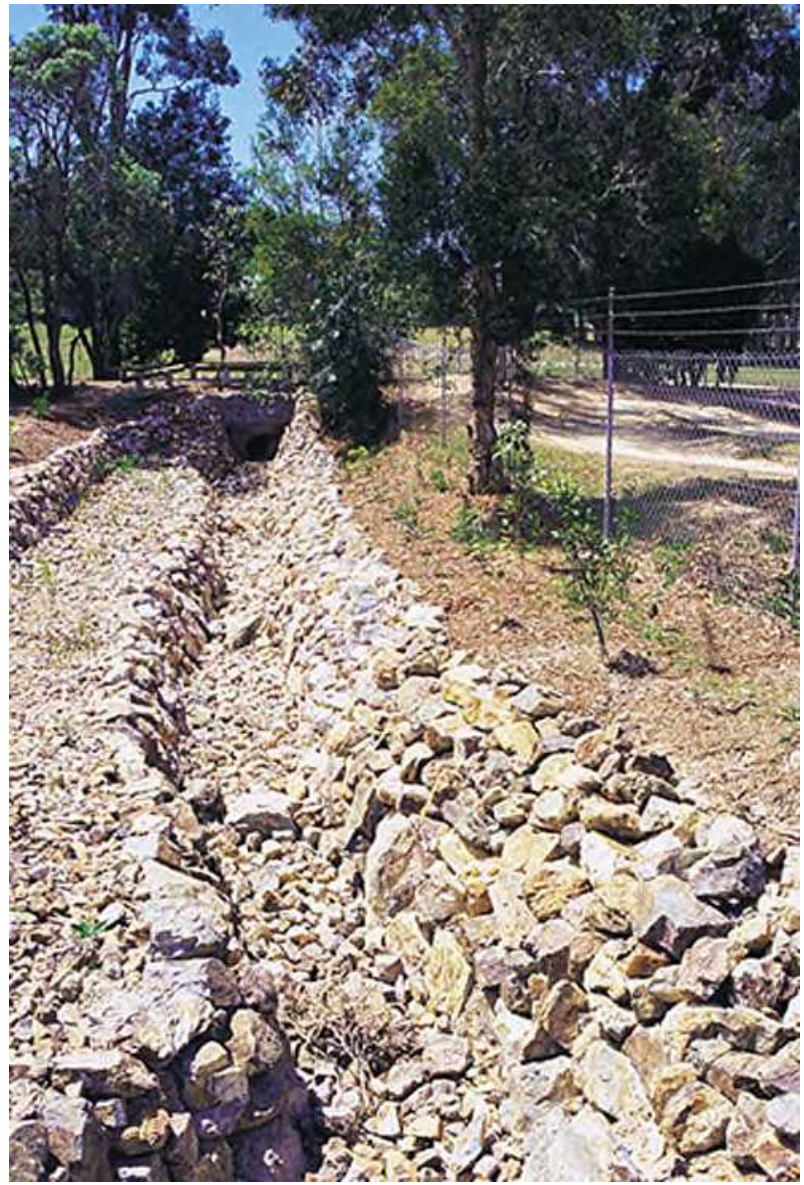
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Landcare - coastcare

Farmers need much technical and financial support to become more environmentally sustainable.

Landcare programs have been established to assist landholders in revegetating the land to reverse soil loss and salinisation.

Rivercare programs help landholders to restore riparian (stream and river) vegetation, which stabilise banks and act as biofilters to trap sediments and nutrients.



Bob Moffatt

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Integrated or total catchment management, which involves all the different uses in a catchment, is a very important approach to the problem.



Coastcare group working to revegetate local headland

Bob Moffatt

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Personal actions

Some of these involved reducing, reusing and recycling our waste, improving the riparian zone in our catchments, thinking globally and acting locally as well as educating others and promoting companies who are really trying to showcase their environmental achievements.



This is not the way to shop.



So how do you shop now to reduce plastic?

By MichalPL - Own work, CC BY-SA 4.0, https://commons.wikimedia.org/w/index.php?curid=63530357

© Wet Paper Publications

Plastic bag reduction is one personal action everyone can take.

How will you go shopping in the future?



By pin add - Self CheckoutUploaded by SchuminWeb, CC BY 2.0
https://commons.wikimedia.org/w/index.php?curid=15503520

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Question

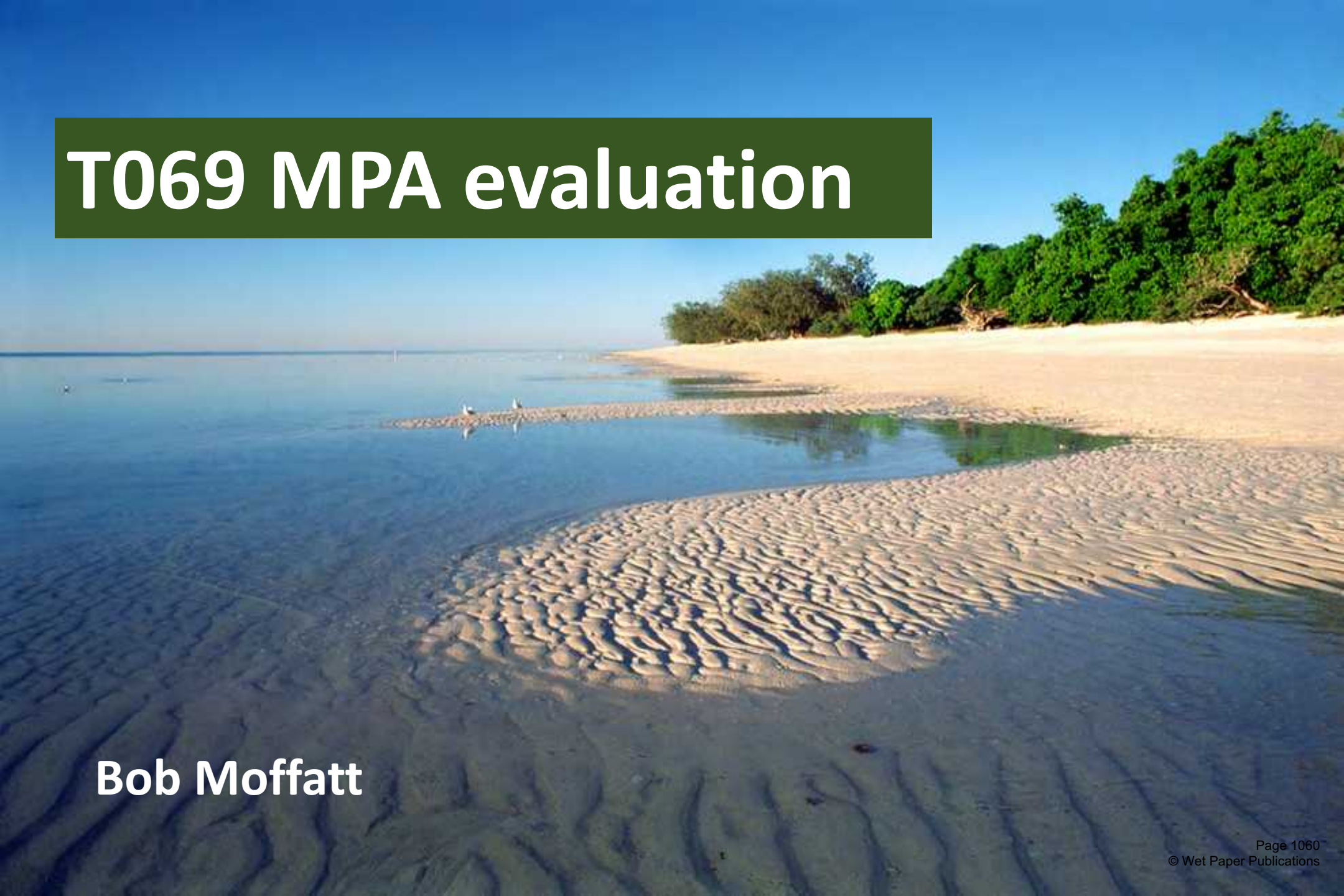
Complete a table comparing the strategies and techniques that could apply to a local marine park or protected area from information provided in this guide.

Compare the strategies and techniques used for marine environmental planning and management with reference to a specific case study

Strategies and technique	Example	Comparison with other strategies and techniques
Zoning plans		
Regulations and standards		
Approvals and permits		
Protection of threatened or significant species		
Protection of threatened habitats and ecosystems		
Multiple-use marine protected areas		
Controls of harmful activities		
Controls on discharges		
Environmental impact assessment		
Economic tools and user-pays		
Environmental restoration		
Clean-up techniques for oil spills		
Prevention of accidents at sea		
Biosecurity measures		
Technological advances		
Action on land to reduce diffuse pollution		
Personal actions		
Engage stakeholders		

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T069 MPA evaluation



Bob Moffatt

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Syllabus statement

At the end of this topic you should be able to ...

Evaluate

the marine environmental planning and management process using primary or secondary data of a specific case study (this may be linked to fieldwork).





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Evaluate

- make an appraisal by weighing up or assessing strengths, implications and limitations;
- make judgments about ideas, works, solutions or methods in relation to selected criteria;
- examine and determine the merit, value or significance of something, based on criteria





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Objective

To show, by using data from a research paper, how the use of no-take zones protect coral reefs from crown of thorns outbreaks.

Data from

https://www.aims.gov.au/docs/data/data.html



Acknowledgement:
Hugh Sweatman
Australian Institute of Marine Science

Research paper from:
http://epubs.aims.gov.au/handle/11068/7783

Pdf version from:
https://core.ac.uk/download/pdf/82736474.pdf

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Current Biology Vol 18 No 14
R598

No-take reserves protect coral reefs from predatory starfish

Hugh Sweatman

The crown-of-thorns starfish, *Acanthaster planci*, is a predator of corals that is a major management issue on coral reefs [1]. It occurs throughout the Indo–Pacific and shows boom–bust population dynamics with low background densities and intermittent outbreaks.

Three waves of population outbreaks have affected Australia's Great Barrier Reef (GBR) since the 1960s.

The waves of outbreaks appear to start ~15°S [2] and progress southward through the central GBR (Figure 1A), causing major losses of living coral on many reefs across a large area and dwarfing losses from other disturbances such as storms or coral bleaching over the same period [3].

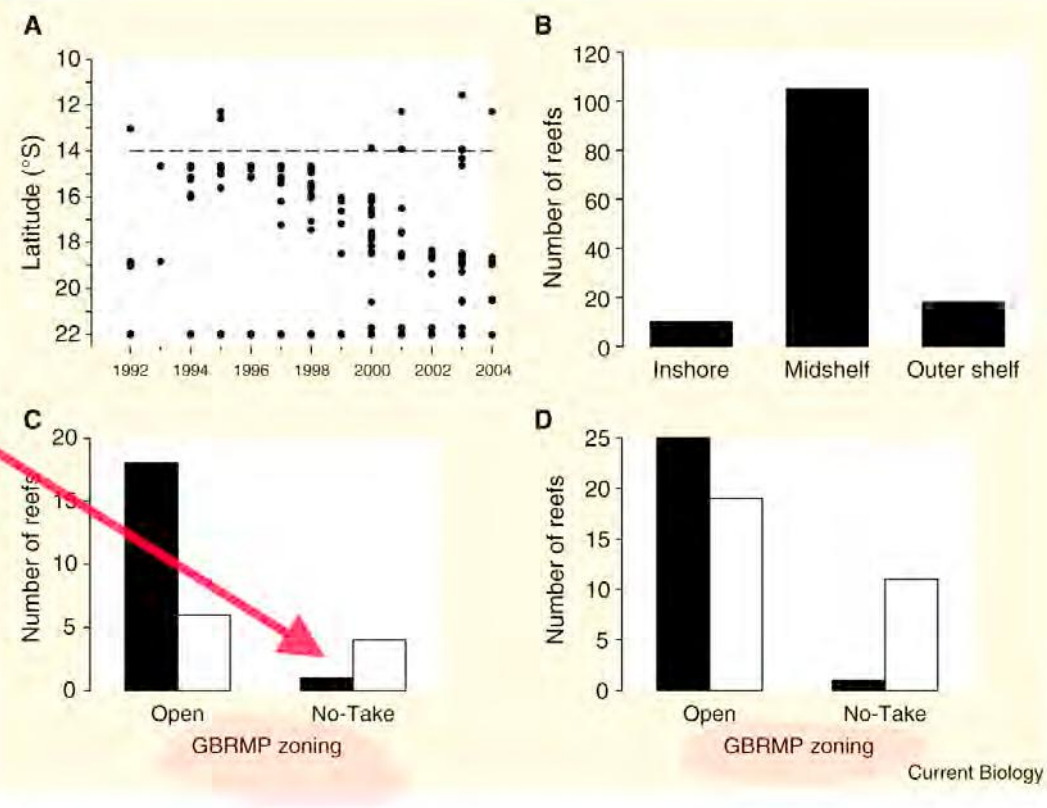


Figure 1. Crown-of-thorns starfish outbreaks on Australia's GBR.

(A) Location of reefs with outbreaks of *A. planci* 1992–2004 by latitude, showing southerly drift in the central GBR (14–21°S) and the consistent presence of outbreaks in the Swain Reefs (~22°S). (B) Number of records of outbreaks 1985–2004 on all GBR reefs grouped by position on the continental shelf. (C) Occurrence of outbreaks 1994–2004 on open and no-take reefs in the mid-shelf region of the GBR where most outbreaks occur; number of reefs with outbreaks (black bars) and without outbreaks (white bars) (n = 29, one-tailed Fisher's exact test p = 0.036). (D) As (C), but including inshore, mid-shelf and outer shelf reefs (n = 56, one-tailed Fisher's ıct test p < 0.003).

https://core.ac.uk/download/pdf/82736474.pdf

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No-take zones (Green zones)

The Marine National Park (Green) Zone is a 'no-take' area and extractive activities like fishing or collecting are not allowed without a permit.

Anyone (with the exception of unattached dories*) can enter a Marine National Park (Green) Zone and participate in activities such as boating, swimming, snorkelling and sailing.

Travelling through a Marine National Park (Green) Zone with fish on board is also allowed (it is only an offence to fish in a Marine National Park (Green) Zone). Fishing gear, such as rods with attached hooks, must be stowed inboard the boat or in rod holders. All fishing apparatus must be out of the water.

Anchoring is also allowed in a Marine National Park (Green) Zone, however in high use and sensitive areas, use of a mooring may be necessary or there may be a no anchoring area defined by buoys. Commercial fishing dories must be attached to a mother vessel at all times whilst in a Marine National Park (Green) Zone.

The Marine National Park (Green) Zone makes up about 33 per cent of the Great Barrier Reef Marine Park.

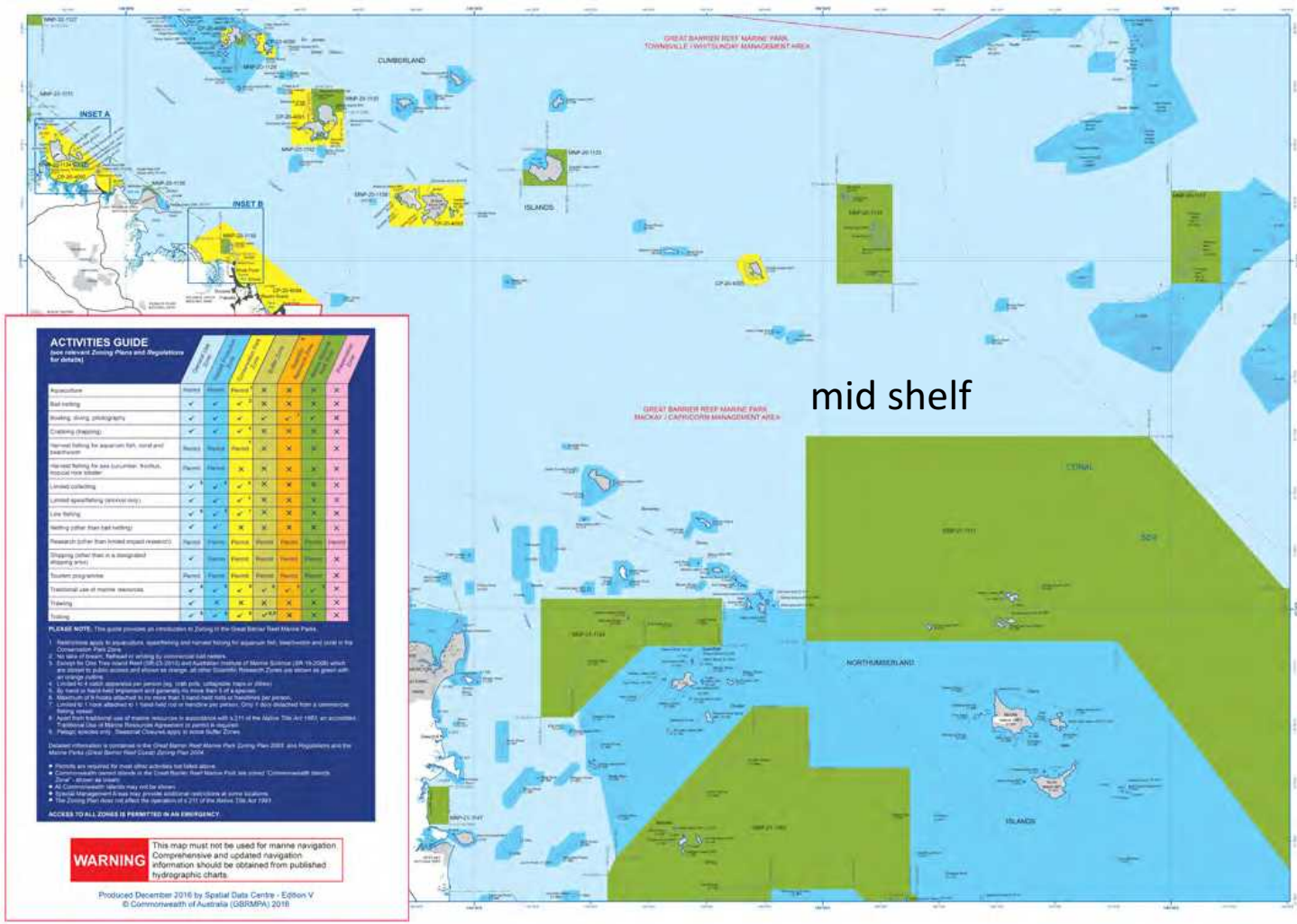
* 'Dories' are vessels used in association with a primary (mother) commercial fishing vessel that is either licensed, permitted, or used, to fish on a commercial basis under a Commonwealth, State or Territory law. Dories must be attached to a primary vessel at all times while in a Marine National Park(Green) Zone.

Aquaculture	No
Bait netting	No
Boating, diving, photography	Yes
Crabbing (trapping)	No
Harvest fishing for aquarium fish, coral and beachworm	No
Harvest fishing for sea cucumber, trochus, tropical rock lobster	No
Limited collecting	No
Limited impact research (non extractive)	Yes
Limited spearfishing (snorkel only)	No
Line fishing	No
Netting (other than bait netting)	No
Research (other than limited impact-non extractive)	Permit
Shipping (other than a designated shipping area)	Permit
Tourism program	Permit
Traditional use of marine resources	Permit (or TUMRA)
Trawling	No
Trolling	No

http://www.gbrmpa.gov.au/visit-the-reef/zoning/zoning-guide-to-using-the-marine-park/interpreting-zones

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The study was from mid shelf reefs on the GBR.



http://www.gbrmpa.gov.au/visit-the-reef/zoning/zoning-guide-to-using-the-marine-park

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Primary data

Available from

https://www.aims.gov.au/docs/data/data.html

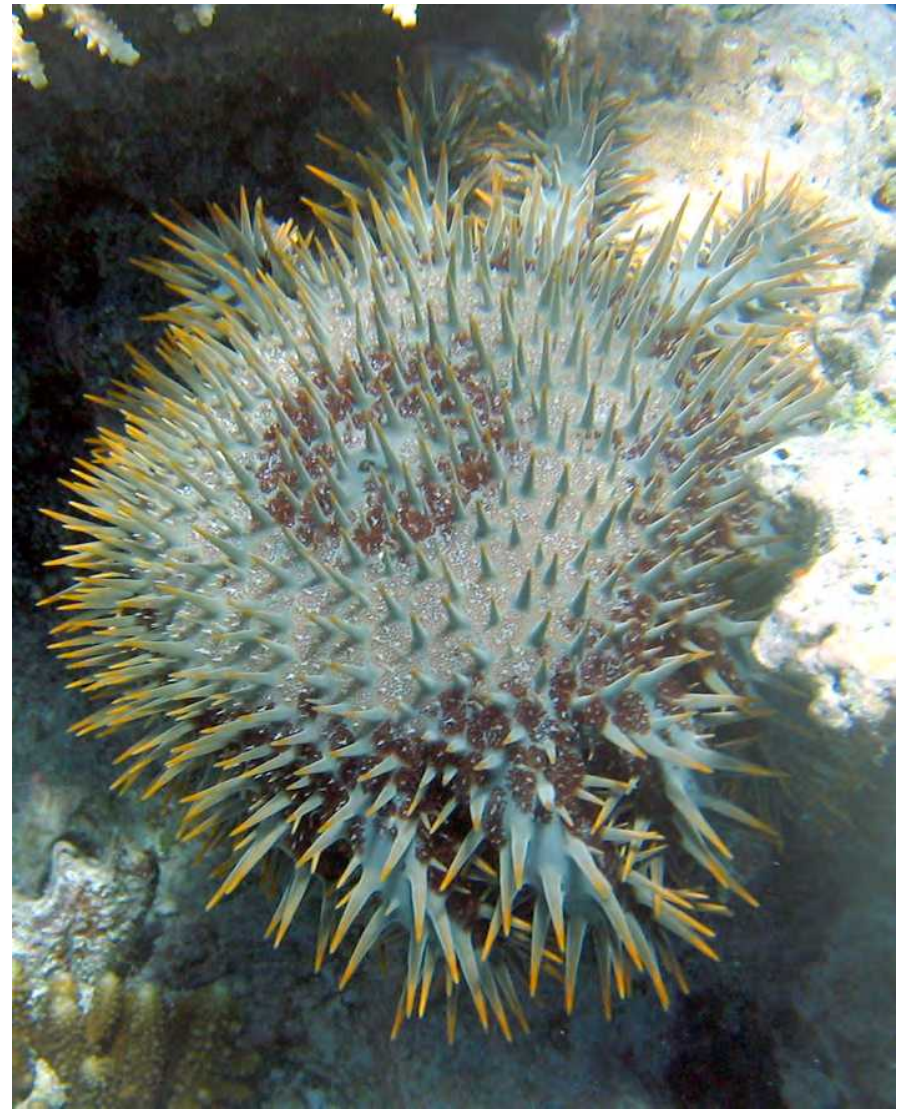
Acknowledgement

All words in “quotes” are from Sweatman’s paper



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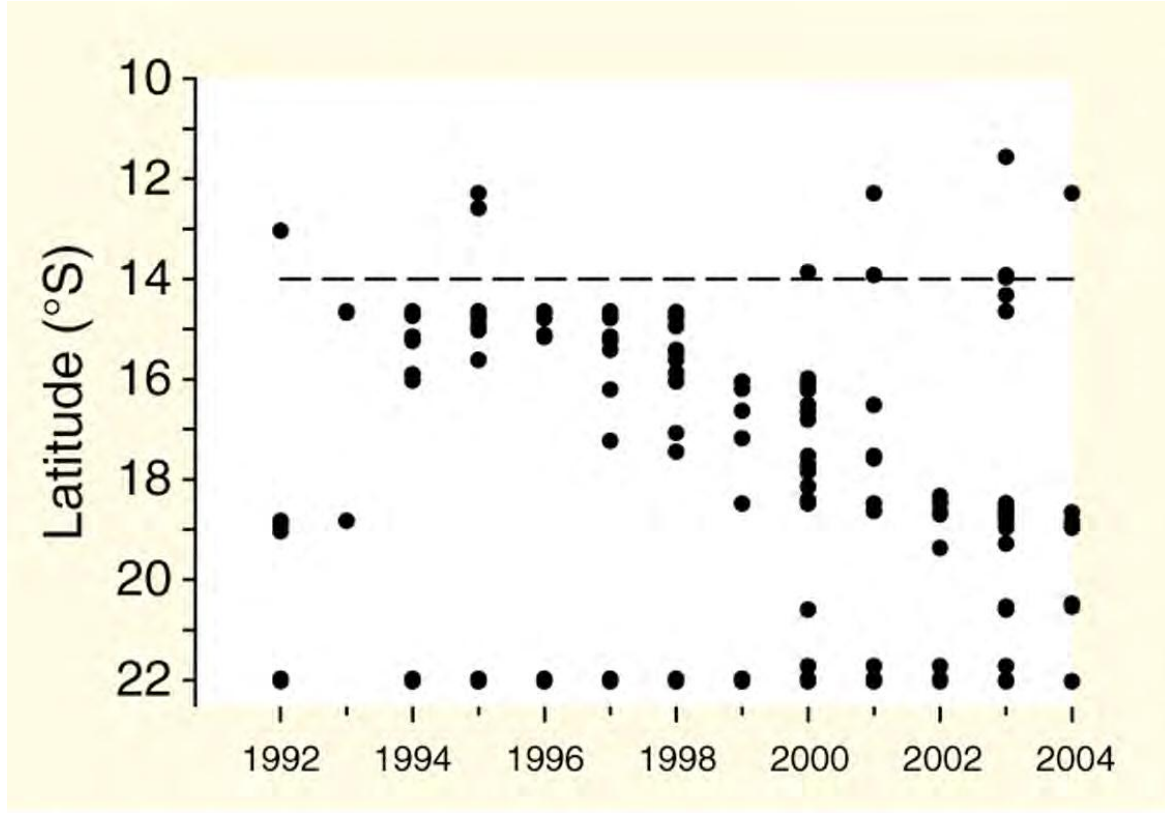
“The crown-of-thorns starfish, Acanthaster planci, is a predator of corals that is a major management issue on coral reefs. It occurs throughout the Indo–Pacific and shows boom–bust population dynamics with low background densities and intermittent outbreaks.”



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“Three waves of population outbreaks have affected Australia’s Great Barrier Reef (GBR) since the 1960s. The waves of outbreaks appear to start ~15˚S and progress southward through the central GBR, causing major losses of living coral on many reefs across a large area and dwarfing losses from other disturbances such as storms or coral bleaching over the same period.”



Location of reefs with outbreaks of *A. planci* 1992–2004 by latitude, showing southerly drift in the central GBR (14–21˚S) and the consistent presence of outbreaks in the Swain Reefs (~22˚S).

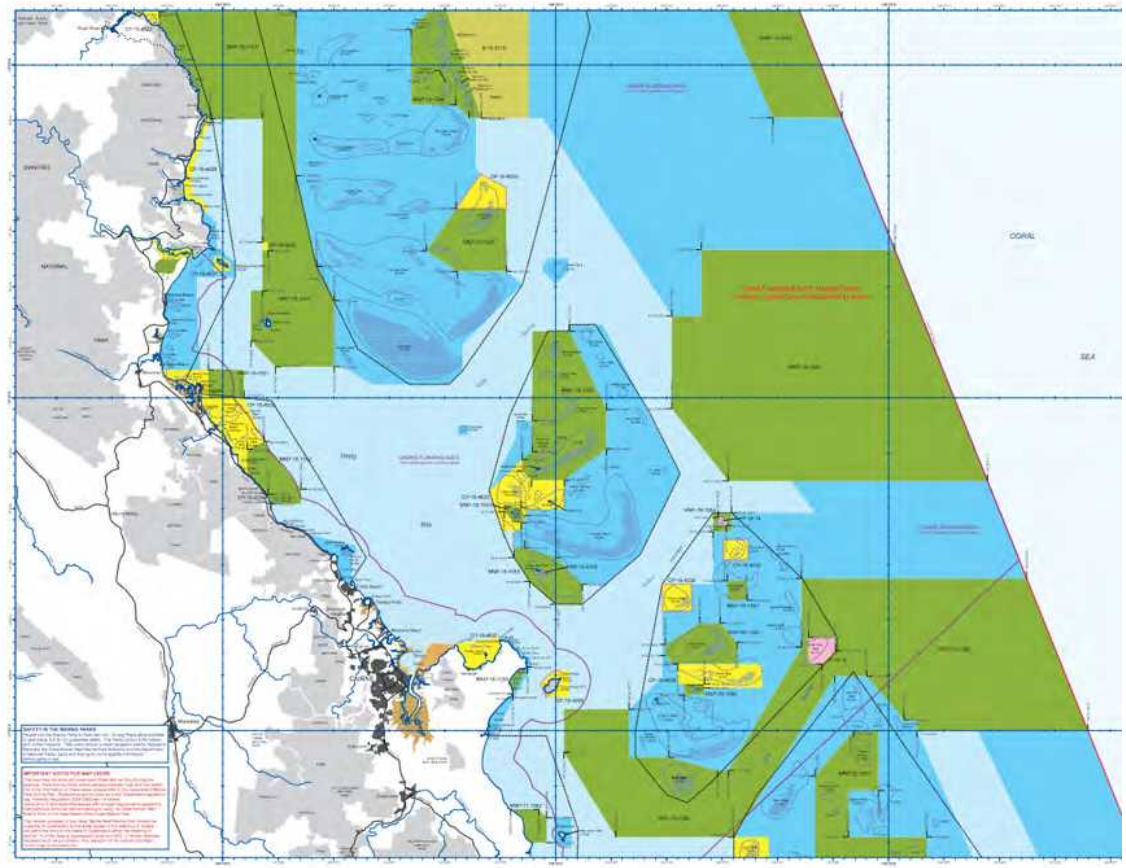
https://core.ac.uk/download/pdf/82736474.pdf

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Method

"To address the question of whether MPAs provide protection from outbreaks of *A. planci* more directly, I compared the frequency of starfish outbreaks on no-take reefs and on reefs that were open to fishing on the GBR, based on results of an extensive monitoring program".

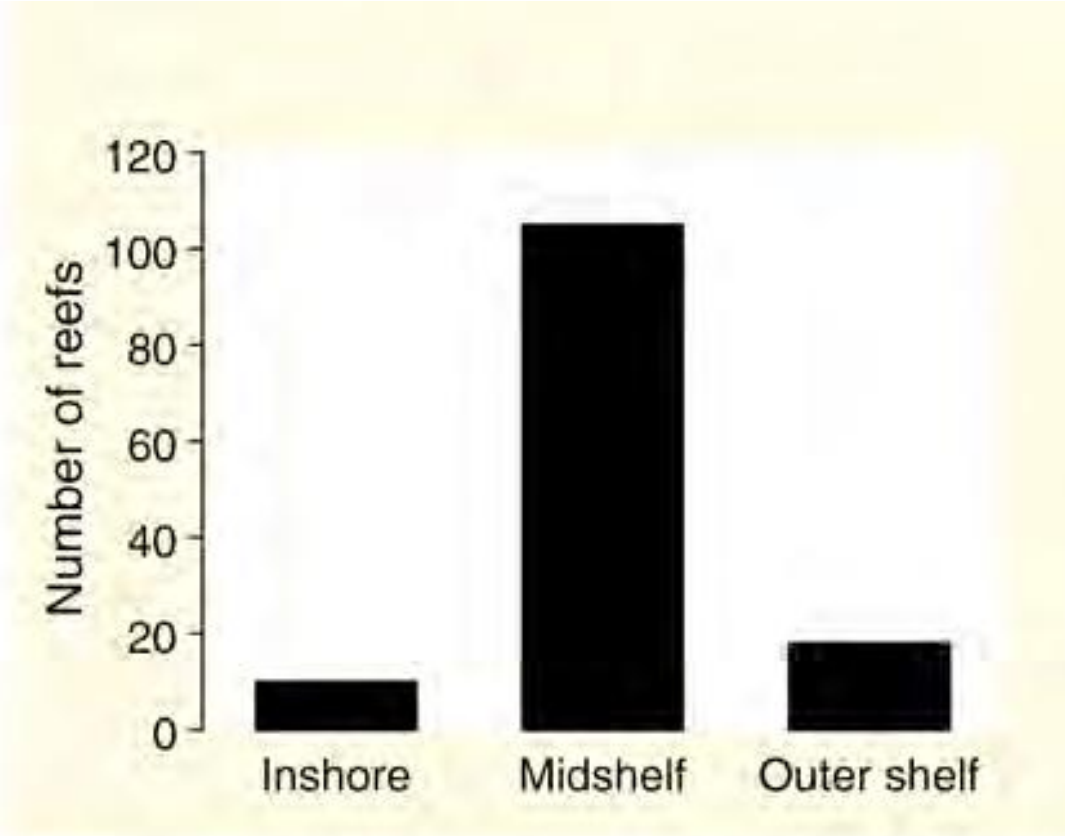
COTS have few predators: giant triton (valued for their shells), white-spotted pufferfish and triton triggerfish. Their main predator the giant triton has been heavily fished for their shells.



GBRMPA

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The number of records of outbreaks 1985–2004 on all GBR reefs grouped by position on the continental shelf can be graphed.

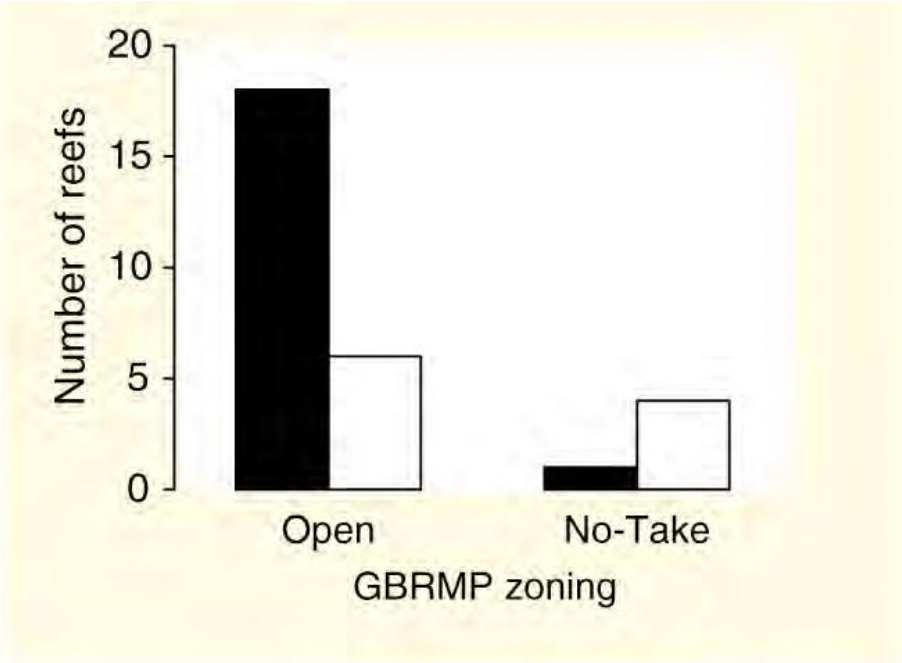


Number of records of outbreaks 1985–2004 on all GBR reefs grouped by position on the continental shelf.

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After allowing at least five years for zoning to take effect, surveys between mid-1994 and mid-2004 showed that proportionately fewer mid-shelf no-take reefs were affected by outbreaks of A. planci (20%), compared with mid-shelf reefs that were open to fishing (75%).



Occurrence of outbreaks 1994–2004 on open and no-take reefs in the mid-shelf region of the GBR where most outbreaks occur;

number of reefs with outbreaks (black bars) without outbreaks (white bars)

(n = 29,

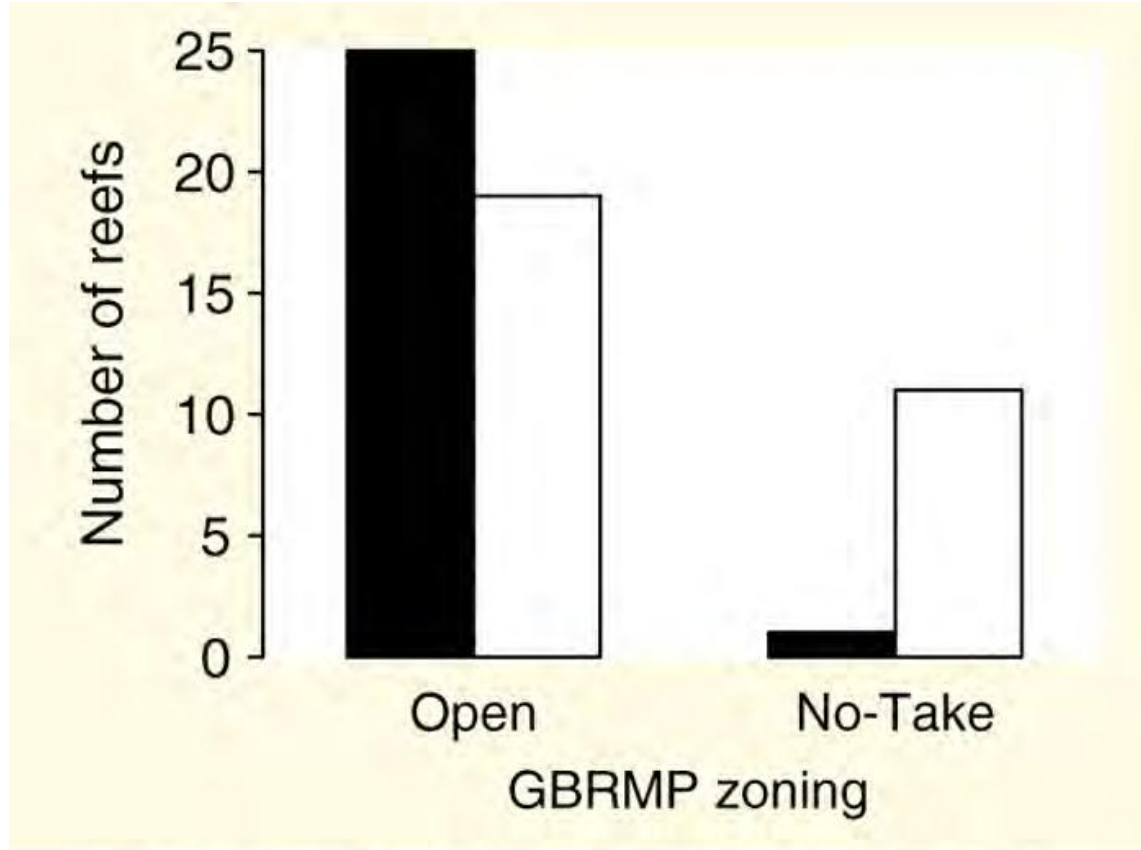
one-tailed Fisher's exact test

p = 0.036)

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When all reefs were considered, the corresponding values were 8% and 57%.



Inshore, mid-shelf and outer shelf reefs (n = 56, one-tailed Fisher's exact test $p < 0.003$).

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What to do now

Read the paper and make an appraisal by weighing up or assessing strengths, implications and limitations using the author's conclusions.

Your teacher will supply the pdf if you can't download it.

This then becomes your evaluation.



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Question

Using data, show how the use of no take zones protect coral reefs from crown of thorns outbreaks.

Data from

https://www.aims.gov.au/docs/data/data.html



Acknowledgement
Hugh Sweatman
Australian Institute of Marine Science

Research paper from
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